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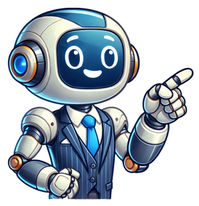

Update: This article was last updated on 10th July 2023 to reflect the accuracy and up-to-date information on the page.Many students have a complicated relationship with mathematics. Some enjoy solving complex problems, while others struggle with its concepts and applications. However, for the majority, it can be intimidating and challenging.Getting good grades in mathematics feels like climbing the steepest mountain without safety gear. One wrong turn and youd never reach the destination. With so many complexities involved, its only fair to wish that someone hadnt invented mathematics in the first place, right?But was it invented by one person?Contrary to popular belief, math was discovered and not invented. It has been around since the dawn of civilization when people used tally marks to keep track of numbers.Numerous mathematicians made significant contributions across various regions around the world, leading to the collective development of mathematics. Hence, we cannot attribute the invention of mathematics to any single individual. Nevertheless, Archimedes holds the title of Father of Mathematics due to his profound impact and notable achievements in the field.Today, It has become an integral part of our everyday lives, helping us to calculate, think critically, and solve problems.So where did it all begin? What have been the contributions so far?The ancient Sumerians, known for establishing one of the earliest civilizations in Mesopotamia, left behind evidence of their advanced mathematical knowledge. Dating back to 3000 BC, they developed a sophisticated metrology system, showcasing their prowess in measurement and numerical calculations. Their contributions to written mathematics laid the foundation for future mathematical advancements and the development of mathematical methods worldwide. The Sumerians mathematical achievements testify to their intellectual capabilities and invaluable contributions to mathematics.Lets break down the discovery of mathematical inventions in simple steps that you can easily learn, absorb, and flaunt.Breakdown of the history of mathematical inventions:1. Ancient Mathematical SystemsAncient mathematics was used to solve various problems before the advent of modern mathematics. Ancient mathematicians developed several systems to make calculations easier. Here is a glimpse of famous discoveries:The Egyptian Mathematics: Egyptian mathematical hieratic system was used to simplify calculations by using symbols to represent numbers and to measure and calculate land, taxes, and other goods. The Egyptian zero, dating back at least four thousand years, fulfilled the roles of representing a magnitude or serving as a separator for directions, if it was regarded purely in that context.Babylonian Mathematics: Babylonian mathematics was based on the sexagesimal system i.e. they used the number 60 to count and measure time, computational mathematics, and astronomy. Before the first recorded instance of the Indian zero, the Babylonian positional number system featured a zero that served as a mere place-holder symbol. The system also allows Babylonians to perform complex calculations, including multiplication, division, and square roots.Chinese Mathematics: The Chinese decimal system was developed around the same time as the Egyptian System, but their system was much more advanced. They made significant contributions to algebra, trigonometry, and geometry. They also developed the concept of negative numbers. Centuries prior to the Common Era, the field of Chinese mathematics embraced the representation of zero within a well-established positional number system, where it was denoted simply by an empty space.Mayan Mathematics: Mayans were skilled in arithmetic, geometry, and astronomy. They developed a base-20 system but are widely known for their calendar system based on mathematical calculations. The calendar system made predictions about the movement of celestial bodies.Though in a modified form, these ancient systems are still in use today.2. Greek MathematicsGreek mathematics can be traced back to the 6th century BC and has had an immense influence on the development of mathematics as a whole. The Greeks developed a sophisticated mathematical system that included geometry, arithmetic, and algebra. They also developed the concept of irrational numbers.Thales of Miletus, Pythagoras, and Euclid are among the most well-known ancient Greek mathematicians, each making major contributions to the field. Thales of Miletus is credited with introducing the concept of mathematical proof and is remembered for discovering the famous Thales theorem.Pythagoras developed the Pythagorean theorem, a cornerstone of geometry, and Euclid is credited with writing the famed Elements, which served as the basis of geometry for centuries.3. Indian MathematicsSome of the earliest recorded mathematical ideas can be traced back to the Indus Valley Civilization, which flourished in the northwestern region of the Indian subcontinent around 2500 BCE.One of the most important developments in Indian mathematics was the invention of the decimal system and the concept of zero, which allowed for more advanced mathematical calculations. This system, now used worldwide, was first developed by Aryabhatta in 500 CE. He is also credited with developing the concept of place value. The westward spread of the Indian zero as a fundamental component of Indian numerals stands as a truly remarkable chapter in the annals of mathematics, and its tale is widely familiar.Other notable mathematicians from India include:Brahmagupta developed the formula for the area of a cyclic quadrilateral and introduced the concept of negative numbers;Vedic Mathematics is the name given to a supposedly ancient system of calculation that was rediscovered from the Vedas between 1911 and 1918 by Sri Bharati Krishna Tirthaji Maharaj (1884-1960).Bhaskara II made important contributions to the study of algebra and calculus; andRamanujan made groundbreaking contributions to number theory and infinite series.4. Middle Eastern MathematicsOne of the most famous mathematical works to come out of the Middle East is Algebra by the Persian mathematician Muhammad ibn Musa al-Khwarizmi, who lived in the 9th century. Al-khwarizmis book laid the foundation for modern algebra and introduced the concept of the algorithm, which is a step-by-step procedure for solving a problem.Another important figure in Middle Eastern mathematics is Omar Khayyam, a Persian mathematician, poet, and philosopher who lived in the 11th and 12th centuries. Khayyam is best known for his study of cubic equations.Islamic mathematics also contributed greatly to the development of trigonometry, which was used extensively in astronomy and navigation. The Persian astronomer Al-Biruni, for example, wrote extensively on the subject of trigonometry, including the first known table of sines.5. Discoveries in the Modern MathematicsModern mathematics is a vast and rapidly evolving field, so here are some highlights of recent discoveries and advancements:The Poincar Conjecture: In 2002, Grigori Perelman proved the Poincar Conjecture, one of the most famous unsolved problems in topology. The conjecture states that any closed, simply connected three-dimensional manifold is topologically equivalent to a three-dimensional sphere.The Langlands Program: This is a set of conjectures that relate number theory and representation theory. It was first proposed by Robert Langlands in the 1960s, and since then, mathematicians have made significant progress in understanding the connections between the two fields. One of the most exciting recent developments was the proof of the Sato-Tate Conjecture, a special case of the Langlands Program.The ABC Conjecture: This is a major unsolved problem in number theory that has been the subject of intense research for several decades. The conjecture relates the prime factors of three integers a, b, and c, and it has important implications for other areas of mathematics. In 2019, Shinichi Mochizuki released a series of papers claiming proof of the ABC Conjecture, but the proof is still under review and has not been widely accepted.Machine Learning and Deep Learning: While not strictly a branch of mathematics, machine learning, and deep learning have revolutionized many fields, including mathematics. These techniques allow mathematicians to analyze vast amounts of data and discover patterns that would be difficult or impossible to detect otherwise. They have been used in areas such as graph theory, algebraic geometry, and number theory, among others.Some Interesting Facts on Math HistoryThe word mathematics originates from the Greek word mathema, which means knowledge or learning. The ancient Egyptians used a system of hieroglyphic symbols to represent numbers. They even had special symbols for fractions, and their number system was base 10. The Chinese abacus, an ancient calculating tool, dates back more than 2,000 years. It was widely used for arithmetic calculations and is still used in some parts of the world today. The concept of negative numbers was initially viewed with skepticism and considered absurd. It wasnt until the 16th century that negative numbers were accepted as valid mathematical entities. The famous mathematician and philosopher Ren Descartes, known for his contributions to analytic geometry, was also an avid coffee drinker. He believed that caffeine helped him think more clearly and work longer hours. In the 17th century, a dispute known as the Brounckers controversy arose between mathematicians William Brouncker and John Wallis over the value of the mathematical constant (pi). They both calculated approximations for , with Wallis claiming it was infinite and Brouncker asserting that it could be expressed as a finite fraction. The concept of imaginary numbers, which involve the square root of negative numbers, was once considered absurd and met with resistance from mathematicians. However, imaginary numbers are now widely used in various branches of mathematics and physics. The ancient Greeks were fascinated by perfect numbers, which are numbers that are equal to the sum of their divisors (excluding the number itself). The first four perfect numbers known to the Greeks were 6, 28, 496, and 8128. The Swiss mathematician Leonhard Euler, known for his extensive contributions to various mathematical fields, was completely blind in his right eye. Despite this, he continued to produce groundbreaking work and is regarded as one of the greatest mathematicians in history. In the Thai language, the number 5 is commonly pronounced as Ha. Consequently, the numerical sequence 555 is occasionally used as a slang expression for Hahaha.This article is just a small glimpse of the vast and varied contributions to mathematics over the centuries. From the earliest counting systems to the equations that underpin modern computing, mathematics has shaped the world we live in today.Recommended Reading: How To Select the Right Math Classes for KidsWant to excite your child about math and sharpen their math skills? Moonpreneurs online math curriculum is unique as it helps children understand math skills through hands-on lessons, assists them in building real-life applications, and excites them to learn math.You can opt for our Advanced Math or Vedic Math+Mental Math courses. Our Math Quiz for grades 3rd, 4th, 5th, and 6th helps in further exciting and engaging in mathematics with hands-on lessons. Mathematics is a field of science that deals with the logic of reason, quantity, arrangement, sequence, and shape. And math is involved in almost everything we do today, whether we know about it or not. It is largely to thank for our mobile phones, computers, tablets, most of our methods of transport, and even our buildings. Math is one of the most important fields of science. But who were the great minds that really put this important field on the map? Where was mathematics invented? Who do we owe this gratitude to? Because maths is so vast, and is involved in so many types of studies, we can not really say that *one person alone* is to be crowned the inventor of math! The field slowly developed over thousands of years and with the help of many savvy individuals! There are traces of mathematics in the history of almost every civilisation. The discoveries of maths increased with the need of the people at the time, as they became more advanced, so too did the discoveries of math. Was maths discovered or invented?Another way to view the question is, instead of when was maths invented, rather, when was maths discovered? If it was always there, such as the laws of physics, was it simply discovered and understood, instead of being invented? Many people argue that mathematics existed way before we found it and had a use for it. Many people suggest that the early adopters of mathematics were the early civilisations such as Greece, India, China, Egypt, and Mesopotamia. Therefore, perhaps nobody invented maths, and people just *discovered* it, just like we make discoveries in the other fields of science! Math History factsThere are many proofs, and truths about mathematics that make sense way before mathematicians could make sense of them. The Sumerians were the first civilisation to have developed a counting system. It is a common belief amongst many scientists that some of the oldest and most basic mathematical functions, such as addition, subtraction, multiplication, and division have been used for over 4,000 years. The workbooks used in those times were clay tablets in ancient Mesopotamia.There are also examples of the Egyptians having made mathematical discoveries dating back around 4,000 years and seen on Egyptian papyruses (an ancient writing material). In Central America, the Mayans were using mathematics to further their understanding of astronomy. They developed elaborate calendars and used maths as a means to understand the passing of time.The history of mathematics then began to speed up when discoveries were then formalised and became an organised science in Greece around 2,500 to 3,000 years ago. Once the ancient Greeks began discovering explanations for natural phenomena and put some of the foundations on arithmetic and geometry, the discoveries in applied mathematics began to greatly accelerate. The concept of geometry allows for the construction of structures, vehicles, and cities. History of mathsIt is supposed that math was made out of a result of necessity, such as needing to count, that it is not surprising that the first parts of math to be discovered were the basic parts of math. Whether it was rationing a food supply or preparing the ranks of an army for battle, the basics of math functions were needed. This is why it is agreed amongst scientists that the oldest (4,000 years) mathematical models were the simplest! Once there was a widely accepted and understood use of the basics of mathematics, the science evolved and grew, slowly over time, into what we know of it today, such as geometry, algebra, differential geometry, calculus, trigonometry, and even probability.Like many fields of science, once there was a widespread acceptance of a particular phenomenon, the continual discoveries kept coming time after time. Once many people saw mathematics as an organised science and realised the benefits of putting the science to use, many in the world began to understand and develop more mathematical proofs. And that is when we began to name the great names behind the equations, such as the great mathematicians, Pythagoras and Euclid. Pythagoras discoveries regarding the sides of a triangle were around 2,500 years ago and spurred many other discoveries in geometry, although we still definitely remember his name. All of the great names, that researched, tested, and formalised understanding of theorem are remembered today through the names of particular theorems and mathematical terms.As such, the answer as to who really invented math is one without an answer. It was discovered, and by many people, over many millennia. We think it is nicer to say that the world, as a whole, is responsible for math, and humanity is responsible for its discovery .The abacus, one of the first counting tools, was invented around 1200 B.C. in China.Algebra's first treatise was written by Diophantus in the 3rd century B.C., laying foundational ideas.Zero, a crucial concept in math, was invented by Hindu mathematicians around 520 A.D. in India. Mathematics is the science of numbers. Tobe precise, the Merriam-Webster dictionary defines mathematics as: The science of numbers and their operations, interrelations, combinations, generalizations, abstractions and of space configurations and their structure, measurement, transformationsand generalizations. Thereare several different branches of mathematical science, which include algebra, geometry and calculus. Mathematics is not an invention. Discoveries and laws of science are not considered inventions since inventions are material things and processes. However, there is a history of mathematics, a relationship between mathematics and inventionsand mathematical instruments themselves are considered inventions. According tothe book "Mathematical Thought from Ancient to Modern Times," mathematics as an organized science did not exist until the classical Greek period from 600 to 300 B.C. There were, however, prior civilizations in which the beginnings or rudiments of mathematics were formed. For example, when civilization began to trade, a need to count was created. When humans traded goods, they needed a way to count the goods and to calculate the cost of those goods. The very first device for counting numbers was, of course, the human hand and fingers represented quantities. And to count beyond ten fingers, mankind used natural markers, rocks or shells. From that point, tools such as counting boards and the abacus were invented. Here's a quick tally of important developments introduced throughout the ages, beginning from A to Z. One of the first tools for counting invented, the abacus was invented around 1200 B.C. in China and was used in many ancient civilizations, including Persia and Egypt. The innovative Italians of the Renaissance (14ththrough 16th century) are widely acknowledged to be the fathers of modern accounting. The first treatise on algebra was written by Diophantus of Alexandria in the 3rd century B.C. Algebra comes from the Arabic word al-jabr, an ancient medical term meaning "the reunion of broken parts." Al-Khawarizmi is another early algebra scholar and was the first to teach the formal discipline. Archimedes was a mathematician and inventor from ancient Greecebest known for his discovery of the relationship between the surface and volume of a sphere and its circumscribing cylinder for his formulation of a hydrostatic principle (Archimedes' principle) and for inventing the Archimedes screw (a device for raising water). Gottfried Wilhelm Leibniz (1646-1716) was a German philosopher, mathematician and logician who is probably most well known for having invented differential and integral calculus. He did this independently of Sir Isaac Newton. A graph is a pictorial representation of statistical data or of a functional relationship between variables. William Playfair (1759-1823) is generally viewed as the inventor of most graphical forms used to display data, including line plots, the bar chart, and the pie chart. In 1557, the "=" sign was first used by Robert Record. In 1631, came the ">" sign. Pythagoreanism is a school of philosophy and a religious brotherhood believed to have been founded by Pythagoras of Samos, who settled in Croton in southern Italy about 525 B.C. The group had a profound effect on the development of mathematics. The simple protractor is an ancient device.As an instrument used to construct and measure plane angles, the simple protractor looks like a semicircular disk marked with degrees, beginning with 0 to 180. The first complex protractor was created for plotting the position of a boat on navigational charts. Called a three-arm protractor or station pointer, it was invented in 1801 by Joseph Huddart, a U.S. naval captain. The centerarm is fixed, while the outer two are rotatable and capable of being set at any angle relative to the center one. Circular and rectangular slide rules, an instrument used for mathematical calculations, were both invented by mathematician William Oughtred. Zero was invented by the Hindu mathematicians Aryabhata and Varamihara in India around or shortly after the year 520 A.D.Mathematics is the basis of all science and has come a long way since humans started counting. But when did people start doing math? The answer is complicated because abstract mathematics is thought to be different from counting although counting is the foundation of math and because many advanced types of mathematics, such as calculus, were developed only within the past few hundred years.Humans couldn't have mastered complex and abstract math without figuring out how to count first, and evidence suggests our species was counting tens of thousands of years ago.The Ishango bone from Africa's Congo region indicates that Homo sapiens have been making "tallies" a kind of counting for at least 20,000 years. The 4-inch-long (10 centimeters) bone, probably from a baboon or a bobcat, was found in the 1950s. Researchers think the dozens of parallel notches cut into its surface were a "tally" a recorded count of some unknown item and in 1970, archaeologist Alexander Marshack argued it was a six-month lunar calendar.You may like There's also the Lebombo bone, which was unearthed in southern Africa in the 1970s and was made about 43,000 years ago. It, too, is covered with cut notches and may have been a tally for the 29 days of a lunar month or for a human menstrual cycle.Danish historian of mathematics Jens Hyrup told Live Science that the very ancient origins of counting could never be known but that it might have been inspired by observations of the night sky by early Homo sapiens, before our species left Africa."There was no artificial light then, only the fires within caves," he said. "And when you have no light pollution, the moon and the stars are a wonder to look at."Related: When did humans discover how to use fire?Get the worlds most fascinating discoveries delivered straight to your inbox.Sumerian advancesThe next major step in mathematics came with the ancient Sumerians, who are also credited perhaps coincidently with inventing cuneiform, the earliest known type of writing.The Sumerians were one of the first Mesopotamian civilizations, and their city-states thrived in what's now southern Iraq from about 4500 to 1900 B.C. Among their key contributions were numerals that could be written on clay tablets in cuneiform's wedge-shaped marks, and the sexagesimal number system, which is the traditional base-60 system still used today for trigonometry, navigation and timekeeping.Mathematics, as opposed to simple counting, is the study of patterns and relationships using logical reasoning and abstract concepts. The ancient Sumerians developed the concepts of arithmetic including tables for multiplication and division and algebra, where unknown quantities were represented by symbols. They also developed formulas to calculate the areas of triangles, rectangles and irregular shapes, with which they measured land and designed irrigation systems.St. Lawrence University mathematician Duncan Melville told Live Science these developments were driven by the growing Sumerian bureaucracy."Record-keepers needed to know not just what came into or left their stores, but how much or how many," he said in an email. Different mathematical notations were used depending on what was measured, and Sumerian scribes converted between these systems in tasks such as finding the area of a field from its measurements. "In this way we see the beginnings of arithmetic and computational geometry," he said.Modern mathIn addition to the developments of the Sumerians and their Mesopotamian successors, especially the Babylonians, early mathematical expertise and innovations came from ancient Egypt, Greece, India and China, and later from the Islamic civilization.Mathematics flourished in early modern Europe, where two scientists both claimed to have invented calculus a way to determine the geometric area enclosed by any curve and an important advance in mathematics that underpins much of modern engineering and science.One was Isaac Newton, who said he'd invented calculus for his 1687 work "Principia Mathematica" (although he called his calculus "the method of fluxions"), and the other was the German polymath Gottfried Wilhelm Leibniz, who had published a mathematical system of differentials and integrals a few years earlier. (His notation is still used today.)The two men and their supporters engaged in a bitter dispute about who deserved recognition for the invention, which included allegations that Leibniz had snuck a look at Newton's unpublished manuscript. But historians now think Newton and Leibniz developed calculus independently of each other. Pi quiz: How much do you know about this irrational number? Mathematics is not a creation but rather a finding initially introduced to the world by Greek mathematicians. This is why the term mathematics is derived from the Greek word mathema, which means knowledge. Mathematics is a field of study concerned with the logical relationship between reason, amount, order, and shape. It was not found by a single mathematician but rather by a group of mathematicians worldwide working simultaneously. When did it first begin, though? The different kinds of maths we study today, like Algebra, Geometry, and Calculus, are not the beginning. Lets talk about the people who made mathematical discoveries and the periods in which they occurred. Ancient people were the first to adopt mathematics to count! Numerous times a day, we count using mathematics. Similarly, in ancient times, people used mathematics unconsciously to count, add, subtract, and divide, despite their lack of mathematical education. Babylonian mathematics refers to any mathematics practiced by the peoples of Mesopotamia (now Iraq) from the time of the Sumerians to the Christian era. Sumerians, who built the first civilization in Mesopotamia, left the earliest evidence of mathematics in writing. In 3000 BCE, they created a sophisticated system of metrology. In 2500 B.C., the Sumerians used clay tablets to record multiplication tables, geometry exercises, and division problems. Additionally, the oldest evidence of Babylonian numbers dates to this time period. Image Source: phys.org In Babylonian mathematics, the sexagesimal (base-60) numeric system was used. This is the origin of the modern usage of 60 seconds per minute, 60 minutes per hour, and 360 degrees in a circle, and seconds and minutes of arc to represent fractions of a degree. In addition, the Babylonians used a place-value system in which, similar to the decimal system, numerals written in the left column represented greater values. The strength of the Babylonian notational system resided in its ability to represent fractions as easily as whole numbers; consequently, the multiplication of two fractional values was identical to the multiplication of integers, similar to current notation. In addition to fractions, algebra, quadratic and cubic equations, and the calculation of regular numbers and their reciprocal pairs, other topics covered by Babylonian mathematics include algebra, calculus, and quadratic and cubic equations. Egyptian mathematics is mathematics that is written in the Egyptian language. The most extensive Egyptian mathematical work is the Rhind papyrus (often sometimes referred to as the Ahmes papyrus after its author), which is dated to approximately 1650 B.C. but is presumably a copy of an older document from the Middle Kingdom between 2000 and 1800 B.C. It is a guidebook for students of mathematics and geometry. In addition to providing area formulas and methods for multiplication, division, and working with unit fractions, it provides evidence of other mathematical knowledge, such as composite and prime numbers, arithmetic, and geometric. It also demonstrates how to solve linear equations of the first order and arithmetic and geometric series. Image Source: classoraclemedia.com The Moscow papyrus, likewise from the Middle Kingdom period and dating to perhaps 1890 B.C., is a notable Egyptian mathematical text. It comprises what is often known now as word problems. In addition, the ancient Egyptians were likely the first to employ measurement units. The Berlin Papyrus 6619 (about 1800 B.C.) demonstrates that ancient Egyptians could solve an equation of the second order. Greek mathematics was significantly more advanced than the mathematics created by primary cultures. All surviving records of pre-Greek mathematics demonstrate the use of inductive reasoning or the utilization of repeated observations to build rules of thumb. In contrast, Greek mathematicians utilized deductive reasoning. The Greeks applied logic to deduce conclusions from definitions and axioms and mathematical rigor to demonstrate their validity. Although the extent of the effect is debatable, Egyptian and Babylonian mathematics likely inspired them. Image Source: onmanorama.com The Pythagorean School was founded by Pythagoras, whose theory was mathematics dominated the universe. Pythagoreans originated the term mathematics, and the study of mathematics begins with them. The Pythagoreans are credited with the first demonstration of the Pythagorean theorem and the evidence of the existence of irrational numbers. Still, the statement of the theorem has a lengthy history. Archimedes of Syracuse (about 287212 BC), usually regarded as the greatest mathematician of antiquity and the father of mathematics, utilized the method of exhaustion to compute the area under the arc of a parabola by summing an infinite series in a manner not different to modern calculus. He also demonstrated that the method of exhaustion could be used to compute the value with the appropriate degree of precision, and he produced the most precise value at the time. In addition, he investigated the spiral that bears his name and derived formulas for the volumes of surfaces of paraboloid, ellipsoid, and hyperboloid. His greatest accomplishment was determining the surface area and volume of a sphere by demonstrating that they are 2/3 the surface area and volume of a cylinder encircling the sphere. Greek mathematics resumed during the Roman Republic and later during the Empire. The development of the Roman calendar also required elementary mathematics. During the Roman Empire in the eighth century B.C., the first calendar supposedly had 356 days plus a leap year every other year. Romans were competent at initiating and detecting financial fraud, as well as managing taxes for the treasury, through the use of arithmetic. Image Source: irishtimes.com Siculus Flaccus, a Roman land surveyor, authored the Categories of Fields, which assisted Roman land surveyors in calculating the surface areas of allocated lands and territories. In addition to handling trade and taxes, the Romans routinely applied mathematics to engineering challenges, such as the construction of bridges, roads, and military campaigns. The oldest surviving Chinese mathematical literature would probably be the Tsinghua Bamboo Slips, which include the first known decimal multiplication table (the Babylonians had tables with a base of 60), dated to approximately 305 BC. Notable in Chinese mathematics is the adoption of a decimal positional writing system, the rod numerals, in which distinct ciphers were employed for integers between 1 and 10, as well as extra ciphers for powers of ten. Image Source: grahamshawcross.com This was the worlds most advanced number system at the time. Rod numerals permitted the display of numbers of any size, and calculations could be performed on the Chinese abacus. The Chinese may have also been the first to calculate negative numbers and Pascals Triangle centuries before Pascal himself performed these calculations. The oldest surviving mathematical documents from India are appendices to religious scriptures, dating between the eighth century B.C. and the second century A.D., that provide simple instructions for building altars of various forms, including squares, rectangles, parallelograms, and others. Additionally, they compute the square root of 2 to many decimal places, provide a list of Pythagorean triples, and express the Pythagorean theorem. Image Source: madrascourier.com The subsequent important mathematical works from India are astronomical treatizes from the fourth and fifth centuries A.D. In contrast to Ptolemaic trigonometry, they contain the earliest instance of trigonometric relations based on the half-chord, as is the case in modern trigonometry. The English sine and cosine originate from the Sanskrit jiya and kojiya through a series of translation blunders. The Islamic world has been credited for preserving mathematical knowledge. In the eighth century, the Islamic Empire created in Persia, the Middle East, Central Asia, North Africa, Iberia, and portions of India made substantial contributions to mathematics. Although the majority of Islamic mathematical writings were written in Arabic, they were not written by Arabs. In the ninth century, the Persian mathematician Muhammad ibn Ms al-Khwarizmi published important works on HinduArabic numerals and equation-solving techniques. The term algorithm is taken from the Latinization of Algoritmis name. He provided a comprehensive explanation for the algebraic solution of quadratic equations with positive roots, and he was the first to teach algebra in its most basic form. Image source: maa.org He also described the essential methods of reduction and balancing, which refer to the inversion of subtracted terms to the opposite side of an equation, i.e., the elimination of like terms on opposite sides of the equation. In his book al-Fakhri, Al-Karaji made additional advances in algebra by extending the methodology to include integer powers and integer roots of unknown values. In the late 11th century, Omar Khayyam composed Discussions on the Difficulties in Euclid, a treatise detailing what he perceived to be errors in Euclids Elements, particularly the parallel postulate. In addition, he was the first person to discover the general geometric solution to cubic equations. He also had a significant impact on calendar change. Image Source: genicap.com In 287 BC, Archimedes was born in Syracuse, Sicily. He was an ancient Greek mathematician. He is commonly referred to as the Father of Mathematics and is credited with developing modern mathematics. He created new methods for solving equations and comprehending geometric concepts. Discovering how to compute the area of a circle was one of his most notable achievements. In addition, he invented a method for determining the volume of a spherical. These discoveries were crucial for comprehending the universe around us. In addition, he studied the spiral bearing his name and established formulas for the surface volumes of the paraboloid, ellipsoid, and hyperboloid. Work by Brahmagupta consisted of principles for computing with zero. Historically, it served as a placeholder. In addition to mathematics, he produced significant achievements in astronomy. The Indian mathematician of the seventh century demonstrated how to find the cube and cube root of an integer and provided rules for squares and square roots. Leonhard Euler was one of the mathematical titans of the 18th century. He was born in Basel, Switzerland. Euler invented, popularised, or standardized most of the notation used by mathematicians today, including e, I f(x) , and the usage of a, b, and c as constants and x, y, and z as unknowns. His attempts to standardize these and other symbols (such as the trigonometric functions) contributed to the internationalization of mathematics and promoted problem-solving collaboration. Due to the simplicity and originality of his algebraic equations, he was commonly hailed as the Father of Algebra. He authored several books on algebra. Later, he became well-known for his book Arithmetica, which provided a brief explanation with examples of the optimal solution for all algebraic equations and the theory associated with numbers. Thales of Miletus was one of the most renowned Greek mathematicians. He is also the first person credited with a mathematical discovery. He was an expert in Geometry and utilized it to calculate the heights of pyramids and determine the distance between a ship and the land. As he was also a philosopher, in the Theorem of Thales, he attempts to apply Geometry through deductive reasoning and draws four corollaries as a result. Pythagoras of Samos was born in approximately 570 B.C. Many mathematical discoveries are attributed to Pythagoras, while his authenticity remains questionable. Perhaps the most well-known is the Pythagorean theorem (named after him). He may have also contributed to the development of the Theory of Proportions. Euclid was a well-known mathematician regarded as the Father of Geometry. His famous contribution to geometry is referred to as Euclidean geometry, which appears in the Geometry chapter of the ninth-grade textbook. He devoted his entire life to mathematics and made a groundbreaking contribution to Geometry. There is no doubt that mathematics has always been one of the most influential fields of study. With the help of the discoveries of ancient mathematicians, further studies are continuing. One of the best mathematicians today is Terence Tao, a former child prodigy who comes in the category of people with the highest I.Q. Keith Devlin and Andrew Sarnak also come to the list of top mathematicians today. We can say that Archimedes is the Father of Mathematics. But, there is no answer to the question of who founded mathematics. It was discovered by numerous individuals throughout many millennia. We believe it is more accurate to say that the entire earth is accountable for mathematics and that humanity is responsible for its discovery. Who invented math? Its a deceptively complex questiona lot harder than 2+2. Math has been around forever, but we are always learning more about it. Short answer: Many different people invented math, including ancient societies and many famous mathematicians who came along later. The long answer: It depends on what kind of math youre asking about. Below is a look at the history of mathematics and the people who contributed to developing math as we know it today. Jump to: According to Britannica Kids, math is the study of numbers. Its a kind of language that we use every day to calculate distances, tell time, build things, and so on. Mathematicians think about math in two areas: pure and applied. Pure math is studying math for its own sake. Figuring out how to solve a particular algorithm or tackling a theory, for example. Applied math is using math to solve real-life problems, like building a house or predicting an earthquake. There are lots of different types of math: arithmetic, algebra, geometry, trigonometry, statistics, and more. So, since math is already a part of the world, the first question is, can math be invented at all? Some mathematicians think that math is invented, as people name aspects of math or create new ways of solving problems. Other people think that math is always therethe concepts and ideas exist in nature, just waiting for us to discover them. Heres a look at the history of math and many of the societies and people who contributed to its development. Jeff Dahl, public domain, via Wikimedia Commons Math has evolved over thousands of years, with input from thousands of mathematicians. We dont know exactly how prehistoric humans dealt with math problems (like counting how many berries they picked, or figuring out the distance between two places), but researchers believe that people were using addition, multiplication, and other math concepts in early China, India, and Mesopotamia. In fact, the oldest clay tablets we have with math inscribed on them are more than 4,000 years old. Theyre from Mesopotamia. We also have Egyptian papyrus sheets with math written on them. So, theres evidence of math from the two oldest societies in the world. Around 1800 B.C.E., the ancient Babylonians developed a number system based on the number 60 (its still used today to think about angle measurement). They were the first people we know of to use actual numbers to represent amounts. Its clear that, considering the pyramids and their society, the Egyptians used math. They definitely understood geometry and even had a formula for calculating the volume of a truncated pyramid. Anderson, CC0, via Wikimedia Commons Theres more information about who invented (or discovered) math concepts as human society evolved. The Greeks, more than 2,500 years ago, started doing more advanced math. Plato, Euclid, and Archimedes are still remembered for their mathematical achievements. For example, Pythagoras studied triangles and he invented what we learn about triangles, called the Pythagorean theorem. We also know that in ancient Greece, math became something to study, and mathematicians started thinking about specific theories and building on one anothers work. Godfrey Kneller, public domain, via Wikimedia Commons After ancient Greece, mathematicians continued making new discoveries and new theories and solving new problems. In 17th-century England, Sir Isaac Newton developed the field of calculus on his own. At the same time, in Germany, Gottfried Leibniz was also involved in developing calculus. Some mathematicians have created problems and hypotheses that have never been solved, like Bernhard Riemann, who created the Riemann hypothesis, which has been attempted but never proven. And throughout history, women have also studied math and invented math concepts. For example, Emmy Noether gained recognition for her innovations in advanced algebra, and Katherine Johnson calculated and analyzed flight paths for spacecraft that sent astronauts to the moon. Mathematicians of color who have made significant contributions to mathematics include Fern Hunt, who created math models to describe different kinds of movement, and Mark Dean, a mathematician and computer scientist who holds patents on the computer that all PCs are based upon. As math has evolved, people are building on what we know to create new types of math and new ways to use math, like applying math to build computers and create game theory, a branch of applied mathematics. So, maybe the question isnt who invented math, but what will math invent next? Use these videos to explore how different math concepts came about. A proof from Euclid's Elements (c.300 BC), widely considered the most influential textbook of all time.[1]Part of a series onMathematicsHistoryIndexAreasNumber theoryGeometryAlgebraCalculus and AnalysisDiscrete mathematicsLogicSet theoryProbabilityStatistics and Decision theoryRelationship with sciencesPhysicsChemistryGeosciencesComputationBiologyLinguisticsEconomicsPhilosophyEducation Mathematics PortalvteThe history of mathematics deals with the origin of discoveries in mathematics and the mathematical methods and notation of the past. Before the modern age and the worldwide spread of knowledge, written examples of new mathematical developments have come to light only in a few locales. From 3000 BC the Mesopotamian states of Sumer, Akkad and Assyria, followed closely by Ancient Egypt and the Levantine state of Ebla began using arithmetic, algebra and geometry for purposes of taxation, commerce, trade and also in the field of astronomy to record time and formulate calendars.The earliest mathematical texts available are from Mesopotamia and Egypt Plimpton 322 (Babylonian c.2000 1900 BC),[2] the Rhind Mathematical Papyrus (Egyptian c. 1800 BC)[3] and the Moscow Mathematical Papyrus (Egyptian c. 1890 BC). All of these texts mention the so-called Pythagorean triples, so, by inference, the Pythagorean theorem seems to be the most ancient and widespread mathematical development after basic arithmetic and geometry.The study of mathematics as a "demonstrative discipline" began in the 6th century BC with the Pythagoreans, who coined the term "mathematics" from the ancient Greek (mathema), meaning "subject of instruction".[4] Greek mathematics greatly refined the methods (especially through the introduction of deductive reasoning and mathematical rigor in proofs) and expanded the subject matter of mathematics.[5] The ancient Romans used applied mathematics in surveying, structural engineering, mechanical engineering, bookkeeping, creation of lunar and solar calendars, and even arts and crafts. Chinese mathematics made early contributions, including a place value system and the first use of negative numbers.[6][7] The HinduArabic numeral system and the rules for the use of its operations, in use throughout the world today evolved over the course of the first millennium AD in India and were transmitted to the Western world via Islamic mathematics through the work of Muammad ibn Ms al-Khwrizm.[8][9] Islamic mathematics, in turn, developed and expanded the mathematics known to these civilizations.[10] Contemporaneous with but independent of these traditions were the mathematics developed by the Maya civilization of Mexico and Central America, where the concept of zero was given a standard symbol in Maya numerals.Many Greek and Arabic texts on mathematics were translated into Latin from the 12th century onward, leading to further development of mathematics in Medieval Europe. From ancient times through the Middle Ages, periods of mathematical discovery were often followed by centuries of stagnation.[11] Beginning in Renaissance Italy in the 15th century, new mathematical developments, interacting with new scientific discoveries, were made at an increasing pace that continues through the present day. This includes the groundbreaking work of both Isaac Newton and Gottfried Wilhelm Leibniz in the development of infinitesimal calculus during the course of the 17th century and following discoveries of German mathematicians like Carl Friedrich Gauss and David Hilbert.The origins of mathematical thought lie in the concepts of number, patterns in nature, magnitude, and form.[12] Modern studies of animal cognition have shown that these concepts are not unique to humans. Such concepts would have been part of everyday life in hunter-gatherer societies. The idea of the "number" concept evolving gradually over time is supported by the existence of languages which preserve the distinction between "one", "two", and "many", but not of numbers larger than two.[12]The use of yarn by Neanderthals some 40,000 years ago at a site in Abri du Maras in the south of France suggests they knew basic concepts in mathematics.[13][14] The Ishango bone, found near the headwaters of the Nile river (northeastern Congo), may be more than 20,000 years old and consists of a series of marks carved in three columns running the length of the bone. Common interpretations are that the Ishango bone shows either a tally of the earliest known demonstration of sequences of prime numbers[15][failed verification] or a six-month lunar calendar.[16] Peter Rudman argues that the development of the concept of prime numbers could only have come about after the concept of division, which he dates to after 10,000 BC, with prime numbers probably not being understood until about 500 BC. He also writes that "no attempt has been made to explain why a tally of something should exhibit multiples of two, prime numbers between 10 and 20, and some numbers that are almost multiples of 10."[17] The Ishango bone, according to scholar Alexander Marshack, may have influenced the later development of mathematics in Egypt as, like some entries on the Ishango bone, Egyptian arithmetic also made use of multiplication by 2; this however, is disputed.[18]Predynastic Egyptians of the 5th millennium BC pictorially represented geometric designs. It has been claimed that megalithic monuments in England and Scotland, dating from the 3rd millennium BC, incorporate geometric ideas such as circles, ellipses, and Pythagorean triples in their design.[19] All of the above are disputed however, and the currently oldest undisputed mathematical documents are from Babylonian and dynastic Egyptian sources.[20]Main article: Babylonian mathematicsSee also: Plimpton 322Babylonian mathematics refers to any mathematics of the peoples of Mesopotamia (modern Iraq) from the days of the early Sumerians through the Hellenistic period almost to the dawn of Christianity.[21] The majority of Babylonian mathematical work comes from two widely separated periods: The first few hundred years of the second millennium BC (Old Babylonian period), and the last few centuries of the first millennium BC (Seleucid period).[22] It is named Babylonian mathematics due to the central role of Babylon as a place of study. Later under the Arab Empire, Mesopotamia, especially Baghdad, once again became an important center of study for Islamic mathematics.Geometry problem on a clay tablet belonging to a school for scribes; Susa, first half of the 2nd millennium BCIn contrast to the sparsity of sources in Egyptian mathematics, knowledge of Babylonian mathematics is derived from more than 400 clay tablets unearthed since the 1850s.[23] Written in Cuneiform script, tablets were inscribed whilst the clay was moist, and baked hard in an oven or by the heat of the sun. Some of these appear to be graded homework.[24]The earliest evidence of written mathematics dates back to the ancient Sumerians, who built the earliest civilization in Mesopotamia. They developed a complex system of metrology from 3000 BC that was chiefly concerned with administrative/financial counting, such as grain allotments, workers, weights of silver, or even liquids, among other things.[25] From around 2500 BC onward, the Sumerians wrote multiplication tables on clay tablets and dealt with geometrical exercises and division problems. The earliest traces of the Babylonian numerals also date back to this period.[26]The Babylonian mathematical tablet Plimpton 322, dated to 1800 BC.Babylonian mathematics were written using a sexagesimal (base-60) numeral system.[23] From this derives the modern-day usage of 60 seconds in a minute, 60 minutes in an hour, and 360 (60 6) degrees in a circle, as well as the use of seconds and minutes of arc to denote fractions of a degree. It is thought the sexagesimal system was initially used by Sumerian scribes because 60 can be evenly divided by 2, 3, 4, 5, 6, 10, 12, 15, 20 and 30,[23] and for scribes (doling out the aforementioned grain allotments, recording weights of silver, etc.) being able to easily calculate by hand was essential, and so a sexagesimal system is pragmatically easier to calculate by hand with; however, there is the possibility that using a sexagesimal system was an ethno-linguistic phenomenon (that might not ever be known), and not a mathematical/practical decision.[27] Also, unlike the Egyptians, Greeks, and Romans, the Babylonians had a place-value system, where digits written in the left column represented larger values, much as in the decimal system. The power of the Babylonian notational system lay in that it could be used to represent fractions as easily as whole numbers; thus multiplying two numbers that contained fractions was no different from multiplying integers, similar to modern notation. The notational system of the Babylonians was the best of any civilization until the Renaissance, and its power allowed it to achieve remarkable computational accuracy; for example, the Babylonian tablet YBC 7289 gives an approximation of 2 accurate to five decimal places.[28] The Babylonians lacked, however, an equivalent of the decimal point, and so the place value of a symbol often had to be inferred from the context.[22] By the Seleucid period, the Babylonians had developed a zero symbol as a placeholder for empty positions; however it was only used for intermediate positions.[22] This zero sign does not appear in terminal positions, thus the Babylonians came close but did not develop a true place value system.[22]Other topics covered by Babylonian mathematics include fractions, algebra, quadratic and cubic equations, and the calculation of regular numbers, and their reciprocal pairs.[29] The tablets also include multiplication tables and methods for solving linear, quadratic equations and cubic equations, a remarkable achievement for the time.[30] Tablets from the Old Babylonian period also contain the earliest known statement of the Pythagorean theorem.[31] However, as with Egyptian mathematics, Babylonian mathematics shows no awareness of the difference between exact and approximate solutions, or the solvability of a problem, and most importantly, no explicit statement of the need for proofs or logical principles.[24]Main article: Egyptian mathematicsImage of Problem 14 from the Moscow Mathematical Papyrus. The problem includes a diagram indicating the dimensions of the truncated pyramid.Egyptian mathematics refers to mathematics written in the Egyptian language. From the Hellenistic period, Greek replaced Egyptian as the written language of Egyptian scholars. Mathematical study in Egypt later continued under the Arab Empire as part of Islamic mathematics, when Arabic became the written language of Egyptian scholars. Archaeological evidence has suggested that the Ancient Egyptian counting system had origins in Sub-Saharan Africa.[32] Also, fractal geometry designs which are widespread among Sub-Saharan African cultures are also found in Egyptian architecture and cosmological signs.[33]The most extensive Egyptian mathematical text is the Rhind papyrus (sometimes also called the Ahmes Papyrus after its author), dated to c. 1650 BC but likely a copy of an older document from the Middle Kingdom of about 20001800 BC.[34] It is an instruction manual for students in arithmetic and geometry. In addition to giving area formulas and methods for multiplication, division and working with unit fractions, it also contains evidence of other mathematical knowledge,[35] including composite and prime numbers; arithmetic, geometric and harmonic means; and simplistic understandings of both the Sieve of Eratosthenes and perfect number theory (namely, that of the number 6).[36] It also shows how to solve first order linear equations[37] as well as arithmetic and geometric series.[38]Another significant Egyptian mathematical text is the Moscow papyrus, also from the Middle Kingdom period, dated to c. 1890 BC.[39] It consists of what are today called word problems or story problems, which were apparently intended as entertainment. One problem is considered to be of particular importance because it gives a method for finding the volume of a frustum (truncated pyramid).Finally, the Berlin Papyrus 6619 (c. 1800 BC) shows that ancient Egyptians could solve a second-order algebraic equation.[40]Main article: Greek mathematicsThe Pythagorean theorem. The Pythagoreans are generally credited with the first proof of the theorem.Greek mathematics refers to the mathematics written in the Greek language from the time of Thales of Miletus (~600 BC) to the closure of the Academy of Athens in 529 AD.[41] Greek mathematicians lived in cities spread over the entire Eastern Mediterranean, from Italy to North Africa, but were united by culture and language. Greek mathematics of the period following Alexander the Great is sometimes called Hellenistic mathematics.[42]Greek mathematics was much more sophisticated than the mathematics that had been developed by earlier cultures. All surviving records of pre-Greek mathematics show the use of inductive reasoning, that is, repeated observations used to establish rules of thumb. Greek mathematicians, by contrast, used deductive reasoning. The Greeks used logic to derive conclusions from definitions and axioms, and used mathematical rigor to prove them.[43]Greek mathematics is thought to have begun with Thales of Miletus (c. 624c.546 BC) and Pythagoras of Samos (c. 582c. 507 BC). Although the extent of the influence is disputed, they were probably inspired by Egyptian and Babylonian mathematics. According to legend, Pythagoras traveled to Egypt to learn mathematics, geometry, and astronomy from Egyptian priests.Thales used geometry to solve problems such as calculating the height of pyramids and the distance of ships from the shore. He is credited with the first use of deductive reasoning applied to geometry, by deriving four corollaries to Thales' Theorem. As a result, he has been hailed as the first true mathematician and the first known individual to whom a mathematical discovery has been attributed.[44] Pythagoras established the Pythagorean School, whose doctrine it was that mathematics ruled the universe and whose motto was "All is number".[45] It was the Pythagoreans who coined the term "mathematics", and with whom the study of mathematics for its own sake begins. The Pythagoreans are credited with the first proof of the Pythagorean theorem,[46] though the statement of the theorem has a long history, and with the proof of the existence of irrational numbers.[47][48] Although he was preceded by the Babylonians, Indians and the Chinese,[49] the Neopythagorean mathematician Nicomachus (60120 AD) provided one of the earliest Greco-Roman multiplication tables, whereas the oldest extant Greek multiplication table is found on a wax tablet dated to the 1st century AD (now found in the British Museum).[50] The association of the Neopythagoreans with the Western invention of the multiplication table is evident in its later Medieval name: the mensa Pythagorica.[51]Plato (428/427 BC 348/347 BC) is important in the history of mathematics for inspiring and guiding others.[52] His Platonic Academy, in Athens, became the mathematical center of the world in the 4th century BC, and it was from this school that the leading mathematicians of the day, such as Eudoxus of Cnidus (c. 390 - c. 340 BC), came.[53] Plato also discussed the foundations of mathematics,[54] clarified some of the definitions (e.g. that of a line as "breadthless length").Eudoxus developed the method of exhaustion, a precursor of modern integration[55] and a theory of ratios that avoided the problem of incommensurable magnitudes.[56] The former allowed the calculations of areas and volumes of curvilinear figures,[57] while the latter enabled subsequent geometers to make significant advances in geometry. Though he made no specific technical mathematical discoveries, Aristotle (384c.322 BC) contributed significantly to the development of mathematics by laying the foundations of logic.[58]One of the oldest surviving fragments of Euclid's Elements, found at Oxyrhynchus and dated to circa AD 100. The diagram accompanies Book II, Proposition 5.[59]In the 3rd century BC, the premier center of mathematical education and research was the Musaeum of Alexandria.[60] It was there that Euclid (c.300 BC) taught, and wrote the Elements, widely considered the most successful and influential textbook of all time.[1] The Elements introduced mathematical rigor through the axiomatic method and is the earliest example of the format still used in mathematics today, that of definition, axiom, theorem, and proof. Although most of the contents of the Elements were already known, Euclid arranged them into a single, coherent logical framework.[61] The Elements was known to all educated people in the West up through the middle of the 20th century and its contents are still taught in geometry classes today.[62] In addition to the familiar theorems of Euclidean geometry, the Elements was meant as an introductory textbook to all mathematical subjects of the time, such as number theory, algebra and solid geometry,[61] including proofs that the square root of two is irrational and that there are infinitely many prime numbers. Euclid also wrote extensively on other subjects, such as conic sections, optics, spherical geometry, and mechanics, but only half of his writings survive.[63]Archimedes used the method of exhaustion to approximate the value of pi.Archimedes (c.287212 BC) of Syracuse, widely considered the greatest mathematician of antiquity,[64] used the method of exhaustion to calculate the area under the arc of a parabola with the summation of an infinite series, in a manner not too dissimilar from modern calculus.[65] He also showed one could use the method of exhaustion to calculate the value of with as much precision as desired, and obtained the most accurate value of then known, 3+10/71 < < 3+10/70.[66] He also studied the spiral bearing his name, obtained formulas for the volumes of surfaces of revolution (paraboloid, ellipsoid, hyperboloid),[65] and an ingenious method of exponentiation for expressing very large numbers.[67] While he is also known for his contributions to physics and several advanced mechanical devices, Archimedes himself placed far greater value on the products of his thought and general mathematical principles.[68] He regarded as his greatest achievement his finding of the surface area and volume of a sphere, which he obtained by proving these are 2/3 the surface area and volume of a cylinder circumscribing the sphere.[69]Apollonius of Perga made significant advances in the study of conic sections.Apollonius of Perga (c.262190 BC) made significant advances to the study of conic sections, showing that one can obtain all three varieties of conic section by varying the angle of the plane that cuts a double-napped cone.[70] He also coined the terminology in use today for conic sections, namely parabola ("place beside" or "comparison"), "ellipse" ("deficiency"), and "hyperbola" ("a throw beyond").[71] His work Conics is one of the best known and preserved mathematical works from antiquity, and in it he derives many theorems concerning conic sections that would prove invaluable to later mathematicians and astronomers studying planetary motion, such as Isaac Newton.[72] While neither Apollonius nor any other Greek mathematicians made the leap to coordinate geometry, Apollonius' treatment of curves is in some ways similar to the modern treatment, and some of his work seems to anticipate the development of analytical geometry by Descartes some 1800 years later.[73]Around the same time, Eratosthenes of Cyrene (c.276194 BC) devised the Sieve of Eratosthenes for finding prime numbers.[74] The 3rd century BC is generally regarded as the "Golden Age" of Greek mathematics, with advances in pure mathematics henceforth in relative decline.[75] Nevertheless, in the centuries that followed significant advances were made in applied mathematics, most notably trigonometry, largely to address the needs of astronomers.[75] Hipparchus of Nicaea (c.190120 BC) is considered the founder of trigonometry for compiling the first known trigonometric table, and to him is also due the systematic use of the 360 degree circle.[76] Heron of Alexandria (c.1070 AD) is credited with Heron's formula for finding the area of a scalene triangle and with being the first to recognize the possibility of negative numbers possessing square roots.[77] Menelaus of Alexandria (c.100 AD) pioneered spherical trigonometry through Menelaus' theorem.[78] The most complete and influential trigonometric work of antiquity is the Almagest of Ptolemy (c.AD 90168), a landmark astronomical treatise whose trigonometric tables would be used by astronomers for the next thousand years.[79] Ptolemy is also credited with Ptolemy's theorem for deriving trigonometric quantities, and the most accurate value of outside of China until the medieval period, 3.1416.[80]Title page of the 1621 edition of Diophantus' Arithmetica, translated into Latin by Claude Gaspard Bachet de Mziriac.Following a period of stagnation after Ptolemy, the period between 250 and 350 AD is sometimes referred to as the "Silver Age" of Greek mathematics.[81] During this period, Diophantus made significant advances in algebra, particularly indeterminate analysis, which is also known as "Diophantine analysis".[82] The study of Diophantine equations and Diophantine approximations is a significant area of research to this day. His main work was the Arithmetica, a collection of 150 algebraic problems dealing with exact solutions to determinate and indeterminate equations.[83] The Arithmetica had a significant influence on later mathematicians, such as Pierre de Fermat, who arrived at his famous Last Theorem after trying to generalize a problem he had read in the Arithmetica (that of dividing a square into two squares).[84] Diophantus also made significant advances in notation, the Arithmetica being the first instance of algebraic symbolism and syncopation.[83]The Hagia Sophia was designed by mathematicians Anthemius of Tralles and Isidore of Miletus.Among the last great Greek mathematicians is Pappus of Alexandria (4th century AD). He is known for his hexagon theorem and centroid theorem, as well as the Pappus configuration and Pappus graph. His Collection is a major source of knowledge on Greek mathematics as most of it has survived.[85] Pappus is considered the last major innovator in Greek mathematics, with subsequent work consisting mostly of commentaries on earlier work.The first woman mathematician recorded by history was Hypatia of Alexandria (AD 350415). She succeeded her father (Theon of Alexandria) as Librarian at the Great Library[citation needed] and wrote many works on applied mathematics. Because of a political dispute, the Christian community in Alexandria had her stripped publicly and executed.[86] Her death is sometimes taken as the end of the era of the Alexandrian Greek mathematics, although work did continue in Athens for another century with figures such as Proclus, Simplicius and Eutocius.[87] Although Proclus and Simplicius were more philosophers than mathematicians, their commentaries on earlier works are valuable sources on Greek mathematics. The closure of the neo-Platonic Academy of Athens by the emperor Justinian in 529 AD is traditionally held as marking the end of the era of Greek mathematics, although the Greek tradition continued unbroken in the Byzantine empire with mathematicians such as Anthemius of Tralles and Isidore of Miletus, the architects of the Hagia Sophia.[88] Nevertheless, Byzantine mathematics consisted mostly of commentaries, with little in the way of innovation, and the centers of mathematical innovation were to be found elsewhere by this time.[89]Further information: Roman abacus and Roman numeralsEquipment used by an ancient Roman land surveyor (gromatici), found at the site of Aquincum, modern Budapest, HungaryAlthough ethnic Greek mathematicians continued under the rule of the late Roman Republic and subsequent Roman Empire, there were no noteworthy native Latin mathematicians in comparison.[90][91] Ancient Romans such as Cicero (10643 BC), an influential Roman statesman who studied mathematics in Greece, believed that Roman surveyors and calculators were far more interested in applied mathematics than the theoretical mathematics and geometry that were prized by the Greeks.[92] It is unclear if the Romans first derived their numerical system directly from the Greek precedent or from Etruscan numerals used by the Etruscan civilization centered in what is now Tuscany, central Italy.[93]Using calculation, Romans were adept at both instigating and detecting financial fraud, as well as managing taxes for the treasury.[94] Siculus Flaccus, one of the Roman gromatici (i.e. land surveyor), wrote the Categories of Fields, which aided Roman surveyors in measuring the surface areas of allotted lands and territories.[95] Aside from managing trade and taxes, the Romans also regularly applied mathematics to solve problems in engineering, including the erection of architecture such as bridges, road-building, and preparation for military campaigns.[96] Arts and crafts such as Roman mosaics, inspired by previous Greek designs, created illusionist geometric patterns and rich, detailed scenes that required precise measurements for each tessera tile, the opus tessellatum pieces on average measuring eight millimeters square and the finer opus vermiculatum pieces having an average surface of four millimeters square.[97][98]The creation of the Roman calendar also necessitated basic mathematics. The first calendar allegedly dates back to 8th century BC during the Roman Kingdom and included 356 days plus a leap year every other year.[99] In contrast, the lunar calendar of the Republican era contained 355 days, roughly ten-and-one-fourth days shorter than the solar year, a discrepancy that was solved by adding an extra month into the calendar after the 23rd of February.[100] This calendar was supplanted by the Julian calendar, a solar calendar organized by Julius Caesar (10044 BC) and devised by Sosigenes of Alexandria to include a leap day every four years in a 365-day cycle.[101] This calendar, which contained an error of 11 minutes and 14 seconds, was later corrected by the Gregorian calendar organized by Pope Gregory XIII (r.15721585), virtually the same solar calendar used in modern times as the international standard calendar.[102]At roughly the same time, the Han Chinese and the Romans both invented the wheeled odometer device for measuring distances traveled, the Roman model first described by the Roman civil engineer and architect Vitruvius (c.80 BC c.15 BC).[103] The device was used at least until the reign of emperor Commodus (r.177192 AD), but its design seems to have been lost until experiments were made during the 15th century in Western Europe.[104] Perhaps relying on similar gear-work and technology found in the Antikythera mechanism, the odometer of Vitruvius featured chariot wheels measuring 4 feet (1.2m) in diameter turning four-hundred times in one Roman mile (roughly 4590ft/1400m). With each revolution, a pin-and-axle device engaged a 400-tooth cogwheel that turned a second gear responsible for dropping pebbles into a box, each pebble representing one mile traversed.[105]Main article: Chinese mathematicsFurther information: Book on Numbers and ComputationSee also: History of science Chinese mathematicsThe Tsinghua Bamboo Slips, containing the world's earliest decimal multiplication table, dated 305 BC during the Warring States periodAn analysis of early Chinese mathematics has demonstrated its unique development compared to other parts of the world, leading scholars to assume an entirely independent development.[106] The oldest extant mathematical text from China is the Zhoubi Suanjing (), variously dated to between 1200 BC and 100 BC, though a date of about 300 BC during the Warring States

Period appears reasonable.[107] However, the Tsinghua Bamboo Slips, containing the earliest known decimal multiplication table (although ancient Babylonians had ones with a base of 60), is dated around 305 BC and is perhaps the oldest surviving mathematical text of China.[49]Counting rod numeralsOf particular note is the use in Chinese mathematics of a decimal positional notation system, the so-called "rod numerals" in which distinct ciphers were used for numbers between 1 and 10, and additional ciphers for powers of ten.[108] Thus, the number 123 would be written using the symbol for "1", followed by the symbol for "100", then the symbol for "2" followed by the symbol for "10", followed by the symbol for "3". This was the most advanced number system in the world at the time, apparently in use several centuries before the common era and well before the development of the Indian numeral system.[109] Rod numerals allowed the representation of numbers as large as desired and allowed calculations to be carried out on the suan pan, or Chinese abacus. The date of the invention of the suan pan is not certain, but the earliest written mention dates from AD 190, in Xu Yue's Supplementary Notes on the Art of Figures.The oldest extant work on geometry in China comes from the philosophical Mohist canon c.330 BC, compiled by the followers of Mozi (470390 BC). The Mo Jing described various aspects of many fields associated with physical science, and provided a small number of geometrical theorems as well.[110] It also defined the concepts of circumference, diameter, radius, and volume.[111]The Nine Chapters on the Mathematical Art, one of the earliest surviving mathematical texts from China (2nd century AD).In 212 BC, the Emperor Qin Shi Huang commanded all books in the Qin Empire other than officially sanctioned ones be burned. This decree was not universally obeyed, but as a consequence of this order little is known about ancient Chinese mathematics before this date. After the book burning of 212 BC, the Han dynasty (202 BC220 AD) produced works of mathematics which presumably expanded on works that are now lost. The most important of these is The Nine Chapters on the Mathematical Art, the full title of which appeared by AD 179, but existed in part under other titles beforehand. It consists of 246 word problems involving agriculture, business, employment of geometry to figure height spans and dimension ratios for Chinese pagoda towers, engineering, surveying, and includes material on right triangles.[107] It created mathematical proof for the Pythagorean theorem,[112] and a mathematical formula for Gaussian elimination.[113] The treatise also provides values of ,[107] which Chinese mathematicians originally approximated as 3 until Liu Xin (d. 23 AD) provided a figure of 3.1457 and subsequently Zhang Heng (78139) approximated pi as 3.1724,[114] as well as 3.162 by taking the square root of 10.[115][116] Liu Hui commented on the Nine Chapters in the 3rd century AD and gave a value of accurate to 5 decimal places (i.e. 3.14159).[117][118] Though more of a matter of computational stamina than theoretical insight, in the 5th century AD Zu Chongzhi computed the value of to seven decimal places (between 3.1415926 and 3.1415927), which remained the most accurate value of for almost the next 1000 years.[117][119] He also established a method which would later be called Cavalieri's principle to find the volume of a sphere.[120]The high-water mark of Chinese mathematics occurred in the 13th century during the latter half of the Song dynasty (9601279), with the development of Chinese algebra. The most important text from that period is the Precious Mirror of the Four Elements by Zhu Shijie (12491314), dealing with the solution of simultaneous higher order algebraic equations using a method similar to Horner's method.[117] The Precious Mirror also contains a diagram of Pascal's triangle with coefficients of binomial expansions through the eighth power, though both appear in Chinese works as early as 1100.[121] The Chinese also made use of the complex combinatorial diagram known as the magic square and magic circles, described in ancient times and perfected by Yang Hui (AD 12381298).[121]Even after European mathematics began to flourish during the Renaissance, European and Chinese mathematics were separate traditions, with significant Chinese mathematical output in decline from the 13th century onwards. Jesuit missionaries such as Matteo Ricci carried mathematical ideas back and forth between the two cultures from the 16th to 18th centuries, though at this point far more mathematical ideas were entering China than leaving.[121]Japanese mathematics, Korean mathematics, and Vietnamese mathematics are traditionally viewed as stemming from Chinese mathematics and belonging to the Confucian-based East Asian cultural sphere.[122] Korean and Japanese mathematics were heavily influenced by the algebraic works produced during China's Song dynasty, whereas Vietnamese mathematics was heavily indebted to popular works of China's Ming dynasty (13681644).[123] For instance, although Vietnamese mathematical treatises were written in either Chinese or the native Vietnamese Ch Nm script, all of them followed the Chinese format of presenting a collection of problems with algorithms for solving them, followed by numerical answers.[124] Mathematics in Vietnam and Korea were mostly associated with the professional court bureaucracy of mathematicians and astronomers, whereas in Japan it was more prevalent in the realm of private schools.[125]Main article: Indian mathematicsFurther information: History of science Indian mathematicsSee also: History of the HinduArabic numeral systemThe numerals used in the Bakhshali manuscript, dated between the 2nd century BC and the 2nd century AD.Indian numerals in stone and copper inscriptions[126]Ancient Brahmi numerals in a part of IndiaThe earliest civilization on the Indian subcontinent is the Indus Valley civilization (mature second phase: 2600 to 1900 BC) that flourished in the Indus river basin. Their cities were laid out with geometric regularity, but no known mathematical documents survive from this civilization.[127]The oldest extant mathematical records from India are the Sulba Sutras (dated variously between the 8th century BC and the 2nd century AD),[128] appendices to religious texts which give simple rules for constructing altars of various shapes, such as squares, rectangles, parallelograms, and others.[129] As with Egypt, the preoccupation with temple functions points to an origin of mathematics in religious ritual.[128] The Sulba Sutras give methods for constructing a circle with approximately the same area as a given square, which imply several different approximations of the value of . [130][131][a] In addition, they compute the square root of 2 to several decimal places, list Pythagorean triples, and give a statement of the Pythagorean theorem.[131] All of these results are present in Babylonian mathematics, indicating Mesopotamian influence.[128] It is not known to what extent the Sulba Sutras influenced later Indian mathematicians. As in China, there is a lack of continuity in Indian mathematics; significant advances are separated by long periods of inactivity.[128]Pini (c. 5th century BC) formulated the rules for Sanskrit grammar.[132] His notation was similar to modern mathematical notation, and used metarules, transformations, and recursion.[133] Pingala (roughly 3rd1st centuries BC) in his treatise of prosody uses a device corresponding to a binary numeral system.[134][135] His discussion of the combinatorics of meters corresponds to an elementary version of the binomial theorem. Pingala's work also contains the basic ideas of Fibonacci numbers (called mtrmeru).[136]The next significant mathematical documents from India after the Sulba Sutras are the Siddhantas, astronomical treatises from the 4th and 5th centuries AD (Gupta period) showing strong Hellenistic influence.[137] They are significant in that they contain the first instance of trigonometric relations based on the half-chord, as is the case in modern trigonometry, rather than the full chord, as was the case in Ptolemaic trigonometry.[138] Through a series of translation errors, the words "sine" and "cosine" derive from the Sanskrit "jiya" and "kojiya".[138]Explanation of the sine rule in YuktibhAround 500 AD, Aryabhata wrote the Aryabhatiya, a slim volume, written in verse, intended to supplement the rules of calculation used in astronomy and mathematical mensuration, though with no feeling for logic or deductive methodology.[139] It is in the Aryabhatiya that the decimal place-value system first appears. Several centuries later, the Muslim mathematician Abu Rayhan Biruni described the Aryabhatiya as a "mix of common pebbles and costly crystals". [140]In the 7th century, Brahmagupta identified the Brahmagupta theorem, Brahmagupta's identity and Brahmagupta's formula, and for the first time, in Brahma-sphuta-siddhanta, he lucidly explained the use of zero as both a placeholder and decimal digit, and explained the HinduArabic numeral system.[141] It was from a translation of this Indian text on mathematics (c. 770) that Islamic mathematicians were introduced to this numeral system, which they adapted as Arabic numerals. Islamic scholars carried knowledge of this number system to Europe by the 12th century, and it has now displaced all older number systems throughout the world. Various symbol sets are used to represent numbers in the HinduArabic numeral system, all of which evolved from the Brahmi numerals. Each of the roughly dozen major scripts of India has its own numeral glyphs. In the 10th century, Halayudha's commentary on Pingala's work contains a study of the Fibonacci sequence[142] and Pascal's triangle,[143] and describes the formation of a matrix.[citation needed]In the 12th century, Bhskara II,[144] who lived in southern India, wrote extensively on all then known branches of mathematics. His work contains mathematical objects equivalent or approximately equivalent to infinitesimals, the mean value theorem and the derivative of the sine function although he did not develop the notion of a derivative.[145][146] In the 14th century, Narayana Pandita completed his Ganita Kaumudi.[147]Also in the 14th century, Madhava of Sangamagrama, the founder of the Kerala School of Mathematics, found the MadhavaLeibniz series and obtained from it a transformed series, whose first 21 terms he used to compute the value of as 3.14159265359. Madhava also found the Madhava-Gregory series to determine the arctangent, the Madhava-Newton power series to determine sine and cosine and the Taylor approximation for sine and cosine functions.[148] In the 16th century, Jyesthadeva consolidated many of the Kerala School's developments and theorems in the Yukti-bh.[149][150] It has been argued that certain ideas of calculus like infinite series and taylor series of some trigonometry functions, were transmitted to Europe in the 16th century[6] via Jesuit missionaries and traders who were active around the ancient port of Muziris at the time and, as a result, directly influenced later European developments in analysis and calculus.[151] However, other scholars argue that the Kerala School did not formulate a systematic theory of differentiation and integration, and that there is not any direct evidence of their results being transmitted outside Kerala.[152][153][154][155]Main article: Mathematics in medieval IslamSee also: History of the HinduArabic numeral systemPage from The Compendious Book on Calculation by Completion and Balancing by Muhammad ibn Ms al-Khwrizm (c.AD 820)The Islamic Empire established across the Middle East, Central Asia, North Africa, Iberia, and in parts of India in the 8th century made significant contributions towards mathematics. Although most Islamic texts on mathematics were written in Arabic, they were not all written by Arabs, since much like the status of Greek in the Hellenistic world, Arabic was used as the written language of non-Arab scholars throughout the Islamic world at the time.[156]In the 9th century, the Persian mathematician Muammad ibn Ms al-Khwrizm wrote an important book on the HinduArabic numerals and one on methods for solving equations. His book On the Calculation with Hindu Numerals, written about 825, along with the work of Al-Kindi, were instrumental in spreading Indian mathematics and Indian numerals to the West. The word algorithm is derived from the Latinization of his name, Algoritmi, and the word algebra from the title of one of his works, Al-Kitb al-mukhtaar f hsb al-abr wal-muqbala (The Compendious Book on Calculation by Completion and Balancing). He gave an exhaustive explanation for the algebraic solution of quadratic equations with positive roots,[157] and he was the first to teach algebra in an elementary form and for its own sake.[158] He also discussed the fundamental method of "reduction" and "balancing", referring to the transposition of subtracted terms to the other side of an equation, that is, the cancellation of like terms on opposite sides of the equation. This is the operation which al-Khwrizm originally described as al-jabr.[159] His algebra was also no longer concerned "with a series of problems to be resolved, but an exposition which starts with primitive terms in which the combinations must give all possible prototypes for equations, which henceforward explicitly constitute the true object of study." He also studied an equation for its own sake and "in a generic manner, insofar as it does not simply emerge in the course of solving a problem, but is specifically called on to define an infinite class of problems."[160]In Egypt, Abu Kamil extended algebra to the set of irrational numbers, accepting square roots and fourth roots as solutions and coefficients to quadratic equations. He also developed techniques used to solve three non-linear simultaneous equations with three unknown variables. One unique feature of his works was trying to find all the possible solutions to some of his problems, including one where he found 2676 solutions.[161] His works formed an important foundation for the development of algebra and influenced later mathematicians, such as al-Karaji and Fibonacci.Further developments in algebra were made by Al-Karaji in his treatise al-Fakhri, where he extends the methodology to incorporate integer powers and integer roots of unknown quantities. Something close to a proof by mathematical induction appears in a book written by Al-Karaji around 1000 AD, who used it to prove the binomial theorem, Pascal's triangle, and the sum of integral cubes.[162] The historian of mathematics, F. Woepcke,[163] praised Al-Karaji for being "the first who introduced the theory of algebraic calculus." Also in the 10th century, Abul Wafa translated the works of Diophantus into Arabic. Ibn al-Haytham was the first mathematician to derive the formula for the sum of the fourth powers, using a method that is readily generalizable for determining the general formula for the sum of any integral powers. He performed an integration in order to find the volume of a paraboloid, and was able to generalize his result for the integrals of polynomials up to the fourth degree. He thus came close to finding a general formula for the integrals of polynomials, but he was not concerned with any polynomials higher than the fourth degree.[164]In the late 11th century, Omar Khayyam wrote Discussions of the Difficulties in Euclid, a book about what he perceived as flaws in Euclid's Elements, especially the parallel postulate. He was also the first to find the general geometric solution to cubic equations. He was also very influential in calendar reform.[165]In the 13th century, Nasir al-Din Tusi (Nasireddin) made advances in spherical trigonometry. He also wrote influential work on Euclid's parallel postulate. In the 15th century, Ghiyath al-Kashi computed the value of to the 16th decimal place. Kashi also had an algorithm for calculating nth roots, which was a special case of the methods given many centuries later by Ruffini and Horner.Other achievements of Muslim mathematicians during this period include the addition of the decimal point notation to the Arabic numerals, the discovery of all the modern trigonometric functions besides the sine, al-Kindi's introduction of cryptanalysis and frequency analysis, the development of analytic geometry by Ibn al-Haytham, the beginning of algebraic geometry by Omar Khayyam and the development of an algebraic notation by al-Qalasd.[166]During the time of the Ottoman Empire and Safavid Empire from the 15th century, the development of Islamic mathematics became stagnant.The Maya numerals for numbers 1 through 19, written in the Maya scriptIn the Pre-Columbian Americas, the Maya civilization that flourished in Mexico and Central America during the 1st millennium AD developed a unique tradition of mathematics that, due to its geographic isolation, was entirely independent of existing European, Egyptian, and Asian mathematics.[167] Maya numerals used a base of twenty, the vigesimal system, instead of a base of ten that forms the basis of the decimal system used by most modern cultures.[167] The Maya used mathematics to create the Maya calendar as well as to predict astronomical phenomena in their native Maya astronomy.[167] While the concept of zero had to be inferred in the mathematics of many contemporary cultures, the Maya developed a standard symbol for it.[167]Further information: List of medieval European scientists and European science in the Middle AgesSee also: Latin translations of the 12th centuryMedieval European interest in mathematics was driven by concerns quite different from those of modern mathematicians. One driving element was the belief that mathematics provided the key to understanding the created order of nature, frequently justified by Plato's Timaeus and the biblical passage (in the Book of Wisdom) that God had ordered all things in measure, and number, and weight.[168]Boethius provided a place for mathematics in the curriculum in the 6th century when he coined the term quadrivium to describe the study of arithmetic, geometry, astronomy, and music. He wrote De institutione arithmetica, a free translation from the Greek of Nicomachus's Introduction to Arithmetic; De institutione musica, also derived from Greek sources; and a series of excerpts from Euclid's Elements. His works were theoretical, rather than practical, and were the basis of mathematical study until the recovery of Greek and Arabic mathematical works.[169][170]In the 12th century, European scholars traveled to Spain and Sicily seeking scientific Arabic texts, including al-Khwrizm's The Compendious Book on Calculation by Completion and Balancing, translated into Latin by Robert of Chester, and the complete text of Euclid's Elements, translated in various versions by Adelard of Bath, Herman of Carinthia, and Gerard of Cremona.[171][172] These and other new sources sparked a renewal of mathematics.Leonardo of Pisa, now known as Fibonacci, serendipitously learned about the HinduArabic numerals on a trip to what is now Bjaa, Algeria with his merchant father. (Europe was still using Roman numerals.) There, he observed a system of arithmetic (specifically algorism) which due to the positional notation of HinduArabic numerals was much more efficient and greatly facilitated commerce. Leonardo wrote Liber Abaci in 1202 (updated in 1254) introducing the technique to Europe and beginning a long period of popularizing it. The book also brought to Europe what is now known as the Fibonacci sequence (known to Indian mathematicians for hundreds of years before that)[173] which Fibonacci used as an unremarkable example.The 14th century saw the development of new mathematical concepts to investigate a wide range of problems.[174] One important contribution was development of mathematics of local motion.Thomas Bradwardine proposed that speed (V) increases in arithmetic proportion as the ratio of force (F) to resistance (R) increases in geometric proportion. Bradwardine expressed this by a series of specific examples, but although the logarithm had not yet been conceived, we can express his conclusion anachronistically by writing:V = log (F/R).[175] Bradwardine's analysis is an example of transferring a mathematical technique used by al-Kindi and Arnold of Villanova to quantify the nature of compound medicines to a different physical problem.[176]Nicole Oresme (13231382), shown in this contemporary illuminated manuscript with an armillary sphere in the foreground, was the first to offer a mathematical proof for the divergence of the harmonic series.[177]Adam Ries (14921559) is known as the "father of modern calculating" because of his decisive contribution to the recognition that Roman numerals are unpractical and to their replacement by the considerably more practical Arabic numerals.[178]One of the 14th-century Oxford Calculators, William Heytesbury, lacking differential calculus and the concept of limits, proposed to measure instantaneous speed "by the path that would be described by [a body] if... it were moved uniformly at the same degree of speed with which it is moved in that given instant".[179]Heytesbury and others mathematically determined the distance covered by a body undergoing uniformly accelerated motion (today solved by integration), stating that "a moving body uniformly acquiring or losing that increment [of speed] will traverse in some given time a [distance] completely equal to that which it would traverse if it were moving continuously through the same time with the mean degree [of speed]".[180]Nicole Oresme at the University of Paris and the Italian Giovanni di Casali independently provided graphical demonstrations of this relationship, asserting that the area under the line depicting the constant acceleration, represented the total distance traveled.[181] In a later mathematical commentary on Euclid's Elements, Oresme made a more detailed general analysis in which he demonstrated that a body will acquire in each successive increment of time an increment of any quality that increases as the odd numbers. Since Euclid had demonstrated the sum of the odd numbers are the square numbers, the total quality acquired by the body increases as the square of the time.[182]Further information: Mathematics and artDuring the Renaissance, the development of mathematics and of accounting were intertwined.[183] While there is no direct relationship between algebra and accounting, the teaching of the subjects and the books published often intended for the children of merchants who were sent to reckoning schools (in Flanders and Germany) or abacus schools (known as abbaco in Italy), where they learned the skills useful for trade and commerce. There is probably no need for algebra in performing bookkeeping operations, but for complex bartering operations or the calculation of compound interest, a basic knowledge of arithmetic was mandatory and knowledge of algebra was very useful.Piero della Francesca (c. 14151492) wrote books on solid geometry and linear perspective, including De Prospectiva Pingendi (On Perspective for Painting), Trattato dAbaco (Abacus Treatise), and De quinque corporibus regularibus (On the Five Regular Solids).[184][185][186]Portrait of Luca Pacioli, a painting traditionally attributed to Jacopo de' Barbari, 1495, (Museo di Capodimonte).Luca Pacioli's Summa de Arithmetica, Geometria, Proportioni et Proportionalit (Italian: "Review of Arithmetic, Geometry, Ratio and Proportion") was first printed and published in Venice in 1494. It included a 27-page treatise on bookkeeping, "Particularis de Computis et Scripturis" (Italian: "Details of Calculation and Recording"). It was written primarily for, and sold mainly to, merchants who used the book as a reference text, as a source of pleasure from the mathematical puzzles it contained, and to aid the education of their sons.[187] In Summa Arithmetica, Pacioli introduced symbols for plus and minus for the first time in a printed book, symbols that became standard notation in Italian Renaissance mathematics. Summa Arithmetica was also the first known book printed in Italy to contain algebra. Pacioli obtained many of his ideas from Piero Della Francesca whom he plagiarized.In Italy, during the first half of the 16th century, Scipione del Ferro and Niccol Fontana Tartaglia discovered solutions for cubic equations. Gerolamo Cardano published them in his 1545 book Ars Magna, together with a solution for the quartic equations, discovered by his student Lodovico Ferrari. In 1572 Rafael Bombelli published his L'Algebra in which he showed how to deal with the imaginary quantities that could appear in Cardano's formula for solving cubic equations.Simon Stevin's De Thiende ('the art of tenths'), first published in Dutch in 1585, contained the first systematic treatment of decimal notation in Europe, which influenced all later work on the real number system.[188][189]Driven by the demands of navigation and the growing need for accurate maps of large areas, trigonometry grew to be a major branch of mathematics. Bartholomaeus Pitiscus was the first to use the word, publishing his Trigonometria in 1595. Regiomontanus's table of sines and cosines was published in 1533.[190]During the Renaissance the desire of artists to represent the natural world realistically, together with the rediscovered philosophy of the Greeks, led artists to study mathematics. They were also the engineers and architects of that time, and so had need of mathematics in any case. The art of painting in perspective, and the developments in geometry that were involved, were studied intensely.[191]See also: Scientific RevolutionJohannes KeplerGottfried Wilhelm LeibnizThe 17th century saw an unprecedented increase of mathematical and scientific ideas across Europe. Tycho Brahe had gathered a large quantity of mathematical data describing the positions of the planets in the sky. By his position as Brahe's assistant, Johannes Kepler was first exposed to and seriously interacted with the topic of planetary motion. Kepler's calculations were made simpler by the contemporaneous invention of logarithms by John Napier and Jost Brgi. Kepler succeeded in formulating mathematical laws of planetary motion.[192]The analytic geometry developed by Ren Descartes (15961650) allowed those orbits to be plotted on a graph, in Cartesian coordinates.Building on earlier work by many predecessors, Isaac Newton discovered the laws of physics that explain Kepler's Laws, and brought together the concepts now known as calculus. Independently, Gottfried Wilhelm Leibniz, developed calculus and much of the calculus notation still in use today. He also refined the binary number system, which is the foundation of nearly all digital (electronic, solid-state, discrete logic) computers.[193]Science and mathematics had become an international endeavor, which would soon spread over the entire world.[194]In addition to the application of mathematics to the studies of the heavens, applied mathematics began to expand into new areas, with the correspondence of Pierre de Fermat and Blaise Pascal. Pascal and Fermat set the groundwork for the investigations of probability theory and the corresponding rules of combinatorics in their discussions over a game of gambling. Pascal, with his wager, attempted to use the newly developing probability theory to argue for a life devoted to religion, on the grounds that even if the probability of success was small, the rewards were infinite. In some sense, this foreshadowed the development of utility theory in the 18th and 19th centuries.Leonhard EulerThe most influential mathematician of the 18th century was arguably Leonhard Euler (17071783). His contributions range from founding the study of graph theory with the Seven Bridges of Knigsberg problem to standardizing many modern mathematical terms and notations. For example, he named the square root of minus 1 with the symbol i, and he popularized the use of the Greek letter {\displaystyle \pi } to stand for the ratio of a circle's circumference to its diameter. He made numerous contributions to the study of topology, graph theory, calculus, combinatorics, and complex analysis, as evidenced by the multitude of theorems and notations named for him.Other important European mathematicians of the 18th century included Joseph Louis Lagrange, who did pioneering work in number theory, algebra, differential calculus, and the calculus of variations, and Pierre-Simon Laplace, who, in the age of Napoleon, did important work on the foundations of celestial mechanics and on statistics.This section needs additional citations for verification. Please help improve this article by adding citations to reliable sources in this section. Unsourced material may be challenged and removed.Find sources:"History of mathematics"news newspapers books scholar JSTOR (April 2021) (Learn how and when to remove this message)Carl Friedrich GaussThroughout the 19th century mathematics became increasingly abstract.[195] Carl Friedrich Gauss (17771855) epitomizes this trend.[citation needed] He did revolutionary work on functions of complex variables, in geometry, and on the convergence of series, leaving aside his many contributions to science. He also gave the first satisfactory proofs of the fundamental theorem of algebra and of the quadratic reciprocity law.[citation needed]Behavior of lines with a common perpendicular in each of the three types of geometryThis century saw the development of the two forms of non-Euclidean geometry, where the parallel postulate of Euclidean geometry no longer holds.The Russian mathematician Nikolai Ivanovich Lobachevsky and his rival, the Hungarian mathematician Jnos Bolyai, independently defined and studied hyperbolic geometry, where uniqueness of parallels no longer holds. In this geometry the sum of angles in a triangle add up to less than 180. Elliptic geometry was developed later in the 19th century by the German mathematician Bernhard Riemann; here no parallel can be found and the angles in a triangle add up to more than 180. Riemann also developed Riemannian geometry, which unifies and vastly generalizes the three types of geometry, and he defined the concept of a manifold, which generalizes the ideas of curves and surfaces, and set the mathematical foundations for the theory of general relativity.[196]The 19th century saw the beginning of a great deal of abstract algebra. Hermann Grassmann in Germany gave a first version of vector spaces, William Rowan Hamilton in Ireland developed noncommutative algebra.[citation needed] The British mathematician George Boole devised an algebra that soon evolved into what is now called Boolean algebra, in which the only numbers were 0 and 1. Boolean algebra is the starting point of mathematical logic and has important applications in electrical engineering and computer science.[citation needed][197] Augustin-Louis Cauchy, Bernhard Riemann, and Karl Weierstrass reformulated the calculus in a more rigorous fashion.[citation needed]Also, for the first time, the limits of mathematics were explored. Niels Henrik Abel, a Norwegian, and variste Galois, a Frenchman, proved that there is no general algebraic method for solving polynomial equations of degree greater than four (AbelRuffini theorem).[198] Other 19th-century mathematicians used this in their proofs that straight edge and compass alone are not sufficient to trisect an arbitrary angle, to construct the side of a cube twice the volume of a given cube, nor to construct a square equal in area to a given circle.[citation needed] Mathematicians had vainly attempted to solve all of these problems since the time of the ancient Greeks.[citation needed] On the other hand, the limitation of three dimensions in geometry was surpassed in the 19th century through considerations of parameter space and hypercomplex numbers.[citation needed]Abel and Galois's investigations into the solutions of various polynomial equations laid the groundwork for further developments of group theory, and the associated fields of abstract algebra. In the 20th century physicists and other scientists have seen group theory as the ideal way to study symmetry.[citation needed]Georg CantorIn the later 19th century, Georg Cantor established the first foundations of set theory, which enabled the rigorous treatment of the notion of infinity and has become the common language of nearly all mathematics. Cantor's set theory, and the rise of mathematical logic in the hands of Peano, L.E.J. Brouwer, David Hilbert, Bertrand Russell, and A.N. Whitehead, initiated a long running debate on the foundations of mathematics.[citation needed]The 19th century saw the founding of a number of national mathematical societies: the London Mathematical Society in 1865,[199] the Socit Mathmatique de France in 1872,[200] the Circolo Matematico di Palermo in 1884,[201][202] the Edinburgh Mathematical Society in 1883,[203] and the American Mathematical Society in 1888.[204] The first international, special-interest society, the Quaternion Society, was formed in 1899, in the context of a vector controversy.[205]In 1897, Kurt Hensel introduced p-adic numbers.[206]The 20th century saw mathematics become a major profession. By the end of the century, thousands of new Ph.D.s in mathematics were being awarded every year, and jobs were available in both teaching and industry.[207] An effort to catalogue the areas and applications of mathematics was undertaken in Klein's encyclopedia.[208]In a 1900 speech to the International Congress of Mathematicians, David Hilbert set out a list of 23 unsolved problems in mathematics.[209] These problems, spanning many areas of mathematics, formed a central focus for much of 20th-century mathematics. Today, 10 have been solved, 7 are partially solved, and 2 are still open. The remaining 4 are too loosely formulated to be stated as solved or not.[210]A map illustrating the Four Color TheoremNotable historical conjectures were finally proven. In 1976, Wolfgang Haken and Kenneth Appel proved the four color theorem, controversial at the time for the use of a computer to do so.[211] Andrew Wiles, building on the work of others, proved Fermat's Last Theorem in 1995.[212] Paul Cohen and Kurt Gdel proved that the continuum hypothesis is independent of (could neither be proved nor disproved from) the standard axioms of set theory.[213] In 1998, Thomas Callister Hales proved the Kepler conjecture, also using a computer.[214]Mathematical collaborations of unprecedented size and scope took place. An example is the classification of finite simple groups (also called the "enormous theorem"), whose proof between 1955 and 2004 required 500-odd journal articles by about 100 authors, and filling tens of thousands of pages.[215] A group of French mathematicians, including Jean Dieudonn and Andr Weil, publishing under the pseudonym "Nicolas Bourbaki", attempted to exposit all of known mathematics as a coherent rigorous whole. The resulting several dozen volumes has had a controversial influence on mathematical education.[216]Newtonian (red) vs. Einsteinian orbit (blue) of a lone planet orbiting a star, with relativistic precession of apsidesDifferential geometry came into its own when Albert Einstein used it in general relativity.[citation needed] Entirely new areas of mathematics such as mathematical logic, topology, and John von Neumann's game theory changed the kinds of questions that could be answered by mathematical methods.[citation needed] All kinds of structures were abstracted using axioms and given names like metric spaces, topological spaces etc.[citation needed] As mathematicians do, the concept of an abstract structure was itself abstracted and led to category theory.[citation needed] Grothendieck and Serre recast algebraic geometry using sheaf theory.[citation needed] Large advances were made in the qualitative study of dynamical systems that Poincar had begun in the 1890s.[citation needed]Measure theory was developed in the late 19th and early 20th centuries. Applications of measures include the Lebesgue integral, Kolmogorov's axiomatisation of probability theory, and ergodic theory.[citation needed] Knot theory greatly expanded.[citation needed] Quantum mechanics led to the development of functional analysis,[citation needed] a branch of mathematics that was greatly developed by Stefan Banach and his collaborators who formed the Lww School of Mathematics.[217] Other new areas include Laurent Schwartz's distribution theory, fixed point theory, singularity theory and Ren Thom's catastrophe theory, model theory, and Mandelbrot's fractals.[citation needed] Lie theory with its Lie groups and Lie algebras became one of the major areas of study.[218]Non-standard analysis, introduced by Abraham Robinson, rehabilitated the infinitesimal approach to calculus, which had fallen into disrepute in favour of the theory of limits, by extending the field of real numbers to the Hyperreal numbers which include infinitesimal and infinite quantities.[citation needed] An even larger number system, the surreal numbers were discovered by John Horton Conway in connection with combinatorial games.[citation needed]The development and continual improvement of computers, at first mechanical analog machines and then digital electronic machines, allowed industry to deal with larger and larger amounts of data to facilitate mass production and distribution and communication, and new areas of mathematics were developed to deal with this: Alan Turing's computability theory; complexity theory; Derrick Henry Lehmer's use of ENIAC to further number theory and the LucasLehmer primality test; Rzsa Pter's recursive function theory; Claude Shannon's information theory; signal processing; data analysis; optimization and other areas of operations research.[citation needed] In the preceding centuries much mathematical focus was on calculus and continuous functions, but the rise of computing and communication networks led to an increasing importance of discrete concepts and the expansion of combinatorics including graph theory. The speed and data processing abilities of computers also enabled the handling of mathematical problems that were too time-consuming to deal with by pencil and paper calculations, leading to areas such as numerical analysis and symbolic computation.[citation needed] Some of the most important methods and algorithms of the 20th century are: the simplex algorithm, the fast Fourier transform, error-correcting codes, the Kalman filter from control theory and the RSA algorithm of public-key cryptography.[citation needed]At the same time, deep insights were made about the limitations to mathematics. In 1929 and 1930, it was proved[by whom?] the truth or falsity of all statements formulated about the natural numbers plus either addition or multiplication (but not both), was decidable, i.e. could be determined by some algorithm.[citation needed] In 1931, Kurt Gdel found that this was not the case for the natural numbers plus both addition and multiplication; this system, known as Peano arithmetic, was in fact incomplete. (Peano arithmetic is adequate for a good deal of number theory, including the notion of prime number.) A consequence of Gdel's two incompleteness theorems is that in any mathematical system that includes Peano arithmetic (including all of analysis and geometry), truth necessarily outruns proof, i.e. there are true statements that cannot be proved within the system. Hence mathematics cannot be reduced to mathematical logic, and David Hilbert's dream of making all of mathematics complete and consistent needed to be reformulated.[citation needed]The absolute value of the Gamma function on the complex planeOne of the more colorful figures in 20th-century mathematics was Srinivasa Aiyangar Ramanujan (18871920), an Indian autodidact[219] who conjectured or proved over 3000 theorems[citation needed], including properties of highly composite numbers,[220] the partition function[219] and its asymptotics,[221] and mock theta functions.[219] He also made major investigations in the areas of gamma functions,[222][223] modular forms,[219] divergent series,[219] hypergeometric series[219] and prime number theory.[219]Paul Erds published more papers than any other mathematician in history,[224] working with hundreds of collaborators. Mathematicians have a game equivalent to the Kevin Bacon Game, which leads to the Erds number of a mathematician. This describes the "collaborative distance" between a person and Erds, as measured by joint authorship of mathematical papers.[225][226]Emmy Noether has been described by many as the most important woman in the history of mathematics.[227] She studied the theories of rings, fields, and algebras.[228]As in most areas of study, the explosion of knowledge in the scientific age has led to specialization: by the end of the century, there were hundreds of specialized areas in mathematics, and the Mathematics Subject Classification was dozens of pages long.[229] More and more mathematical journals were published and, by the end of the century, the development of the World Wide Web led to online publishing.[citation needed]See also: List of unsolved problems in mathematics Problems solved since 1995In 2000, the Clay Mathematics Institute announced the seven Millennium Prize Problems.[230] In 2003 the Poincar conjecture was solved by Grigori Perelman (who declined to accept an award, as he was critical of the mathematics establishment).[231]Most mathematical journals now have online versions as well as print versions, and many online-only journals are launched.[232][233] There is an increasing drive toward open access publishing, first made popular by arXiv.[citation needed]Main article: Future of mathematicsThere are many observable trends in mathematics, the most notable being that the subject is growing ever larger as computers are ever more important and powerful; the volume of data being produced by science and industry, facilitated by computers, continues expanding exponentially. As a result, there is a corresponding growth in the demand for mathematics to help process and understand this big data.[234] Math science careers are also expected to continue to grow, with the US Bureau of Labor Statistics estimating (in 2018) that "employment of mathematical science occupations is projected to grow 27.9 percent from 2016 to 2026."[235]Mathematics portalArchives of American MathematicsEthnomathematicsHistory of algebraHistory of arithmeticHistory of calculusHistory of combinatoricsHistory of the function conceptHistory of geometryHistory of group theoryHistory of logicHistory of mathematiciansHistory of mathematical notationHistory of measurementHistory of numbersHistory of ancient numeral systemsPrehistoric countingList of books on history of number systemsHistory of number theoryHistory of statisticsHistory of trigonometryHistory of writing numbersKenneth O. May PrizeList of important publications in mathematicsLists of mathematiciansList of mathematics history topicsMathematical folkloreTimeline of mathematics

^ The approximate values for are 4 x (13/15)2 (3.0044...), 25/8 (3.125), 900/289 (3.11418685...), 1156/361 (3.202216...), and 339/108 (3.1389) ^ a b (Boyer 1991, "Euclid of Alexandria" p. 119)^ Friberg, J. (1981). "Methods and traditions of Babylonian mathematics. Plimpton 322, Pythagorean triples, and the Babylonian triangle parameter equations", Historia Mathematica, 8, pp. 277318.^ Neugebauer, Otto (1969) [1957]. The Exact Sciences in Antiquity. Acta Historica Scientiarum Naturalium et Medicinalium. Vol.9 (2ed.). Dover Publications. pp.1191. ISBN978-0-486-22332-2. PMID14884919. Chap. IV "Egyptian Mathematics and Astronomy", pp. 7196.^ Turnbull (1931). "A Manual of Greek Mathematics". Nature. 128 (3235): 5. Bibcode:1931Natur.128..739T. doi:10.1038/128739a0. S2CID3994109.^ Heath, Thomas L. (1963). A Manual of Greek Mathematics, Dover, p. 1: "In the case of mathematics, it is the Greek contribution which it is most essential to know, for it was the Greeks who first made mathematics a science."^ a b Joseph, George Gheverghese (1991). The Crest of the Peacock: Non-European Roots of Mathematics. Penguin Books, London, pp. 14048.^ Ifrah, Georges (1986). Universalgeschichte der Zahlen. Campus, Frankfurt/New York, pp. 42837.^ Kaplan, Robert (1999). The Nothing That Is: A Natural History of Zero. Allen Lane/The Penguin Press, London.^ "The ingenious method of expressing every possible number using a set of ten symbols (each symbol having a place value and an absolute value) emerged in India. The idea seems so simple nowadays that its significance and profound importance is no longer appreciated. Its simplicity lies in the way it facilitated calculation and placed arithmetic foremost amongst useful inventions. the importance of this invention is more readily appreciated when one considers that it was beyond the two greatest men of Antiquity, Archimedes and Apollonius." Pierre Simon Laplace Juschkewitsch, A. P. (1964). Geschichte der Mathematik im Mittelalter. Teubner, Leipzig.^ Eves, Howard (1990). History of Mathematics, 6th Edition, "After Pappus, Greek mathematics ceased to be a living study, ..." p. 185; "The Athenian school struggled on against growing opposition from Christians until the latter finally, in A.D. 529, obtained a decree from Emperor Justinian that closed the doors of the school forever." p. 186; "The period starting with the fall of the Roman Empire, in the middle of the fifth century, and extending into the eleventh century is known in Europe as the Dark Ages... Schooling became almost nonexistent." p. 258.^ a b (Boyer 1991, "Origins" p. 3)^ Hardy, B. 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ISBN0-03-029558-0 p. 141: "No work, except The Bible, has been more widely used..."^ (Boyer 1991, "Euclid of Alexandria" p. 102)^ (Boyer 1991, "Archimedes of Syracuse" p. 120)^ a b (Boyer 1991, "Archimedes of Syracuse" p. 130)^ (Boyer 1991, "Archimedes of Syracuse" p. 126)^ (Boyer 1991, "Archimedes of Syracuse" p. 125)^ (Boyer 1991, "Archimedes of Syracuse" p. 121)^ (Boyer 1991, "Archimedes of Syracuse" p. 137)^ (Boyer 1991, "Apollonius of Perga" p. 145)^ (Boyer 1991, "Apollonius of Perga" p. 146)^ (Boyer 1991, "Apollonius of Perga" p. 152)^ (Boyer 1991, "Apollonius of Perga" p. 156)^ (Boyer 1991, "Greek Trigonometry and Mensuration" p. 161)^ a b (Boyer 1991, "Greek Trigonometry and Mensuration" p. 175)^ (Boyer 1991, "Greek Trigonometry and Mensuration" p. 162)^ S.C. Roy. Complex numbers: lattice simulation and zeta function applications, p. 1 [1]. Harwood Publishing, 2007, 131 pages. ISBN1-904275-25-7^ (Boyer 1991, "Greek Trigonometry and Mensuration" p. 163)^ (Boyer 1991, "Greek Trigonometry and Mensuration" p. 164)^ (Boyer 1991, "Greek Trigonometry and Mensuration" p. 168)^ (Boyer 1991, "Revival and Decline of Greek Mathematics" p. 178)^ (Boyer 1991, "Revival and Decline of Greek Mathematics" p. 180)^ a b (Boyer 1991, "Revival and Decline of Greek Mathematics" p. 181)^ (Boyer 1991, "Revival and Decline of Greek Mathematics" p. 183)^ (Boyer 1991, "Revival and Decline of Greek Mathematics" pp. 18390)^ "Internet History Sourcebooks Project". sourcebooks.fordham.edu.^ (Boyer 1991, "Revival and Decline of Greek Mathematics" pp. 19094)^ (Boyer 1991, "Revival and Decline of Greek Mathematics" p. 193)^ (Boyer 1991, "Revival and Decline of Greek Mathematics" p. 194)^ (Goodman 2016, p.119)^ (Cuomo 2001, pp.194, 20406)^ (Cuomo 2001, pp.19295)^ (Goodman 2016, pp.12021)^ (Cuomo 2001, p.196)^ (Cuomo 2001, pp.20708)^ (Goodman 2016, pp.11920)^ (Tang 2005, pp.1415, 45)^ (Joyce 1979, p.256)^ (Gullberg 1997, p.17)^ (Gullberg 1997, pp.1718)^ (Gullberg 1997, p.18)^ (Gullberg 1997, pp.1819)^ (Needham & Wang 2000, pp.28185)^ (Needham & Wang 2000, p.285)^ (Sleeswyk 1981, pp.188200)^ (Boyer 1991, "China and India" p. 201)^ a b c (Boyer 1991, "China and India" p. 196)^ Katz 2007, pp.19499^ (Boyer 1991, "China and India" p. 198)^ (Needham & Wang 1995, pp.9192)^ (Needham & Wang 1995, p.94)^ (Needham & Wang 1995, p.22)^ (Straffin 1998, p.164)^ (Needham & Wang 1995, pp.99100)^ (Berggren, Borwein & Borwein 2004, p.27)^ (de Crespigny 2007, p.1050)^ a b c (Boyer 1991, "China and India" p. 202)^ (Needham & Wang 1995, pp.10001)^ (Berggren, Borwein & Borwein 2004, pp.20, 2426)^ Zill, Dennis G.; Wright, Scott; Wright, Warren S. (2009). Calculus: Early Transcendentals (3ed.). Jones & Bartlett Learning. p.xxvii. ISBN978-0-7637-5995-7. Extract of p. 27^ a b c (Boyer 1991, "China and India" p. 205)^ (Volkov 2009, pp.15356)^ (Volkov 2009, pp.15455)^ (Volkov 2009, pp.15657)^ (Volkov 2009, p.155)^ Development Of Modern Numerals And Numeral Systems: The Hindu-Arabic system, Encyclopaedia Britannica, Quote: "The 1, 4, and 6 are found in the Ashoka inscriptions (3rd century BC); the 2, 4, 6, 7, and 9 appear in the Nana Ghat inscriptions about a century later; and the 2, 3, 4, 5, 6, 7, and 9 in the Nasik caves of the 1st or 2nd century AD all in forms that have considerable resemblance to todays, 2 and 3 being well-recognized cursive derivations from the ancient = and ."^ (Boyer 1991, "China and India" p. 206)^ a b c d (Boyer 1991, "China and India" p. 207)^ Puttaswamy, T.K. (2000). "The Accomplishments of Ancient Indian Mathematicians". In Selin, Helaine; D'Ambrosio, Ubiratan (eds.). 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This claim and Mdhava's achievements were ignored by Western historians, presumably at first because they could not admit that an Indian discovered the calculus, but later because no one read anymore the Transactions of the Royal Asiatic Society, in which Whish's article was published. The matter resurfaced in the 1950s, and now we have the Sanskrit texts properly edited, and we understand the clever way that Mdhava derived the series without the calculus; but many historians still find it impossible to conceive of the problem and its solution in terms of anything other than the calculus and proclaim that the calculus is what Mdhava found. In this case the elegance and brilliance of Mdhava's mathematics are being distorted as they are buried under the current mathematical solution to a problem to which he discovered an alternate and powerful solution.^ Bressoud, David (2002). "Was Calculus Invented in India?". College Mathematics Journal. 33 (1): 213. doi:10.2307/1558972. JSTOR1558972.^ Plofker, Kim (November 2001). "The 'Error' in the Indian "Taylor Series Approximation" to the Sine". Historia Mathematica. 28 (4): 293. doi:10.1006/hmat.2001.2331. It is not unusual to encounter in discussions of Indian mathematics such assertions as that 'the concept of differentiation was understood [in India] from the time of Manjula (... in the 10th century)' [Joseph 1991, 300], or that 'we may consider Madhava to have been the founder of mathematical analysis' (Joseph 1991, 293), or that Bhaskara II may claim to be 'the precursor of Newton and Leibniz in the discovery of the principle of the differential calculus' (Bag 1979, 294).... The points of resemblance, particularly between early European calculus and the Keralese work on power series, have even inspired suggestions of a possible transmission of mathematical ideas from the Malabar coast in or after the 15th century to the Latin scholarly world (e.g., in (Bag 1979, 285))... It should be borne in mind, however, that such an emphasis on the similarity of Sanskrit (or Malayalam) and Latin mathematics risks diminishing our ability fully to see and comprehend the former. To speak of the Indian 'discovery of the principle of the differential calculus' somewhat obscures the fact that Indian techniques for expressing changes in the Sine by means of the Cosine or vice versa, as in the examples we have seen, remained within that specific trigonometric context. The differential 'principle' was not generalized to arbitrary functions in fact, the explicit notion of an arbitrary function, not to mention that of its derivative or an algorithm for taking the derivative, is irrelevant here^ Katz, Victor J. (June 1995). "Ideas of Calculus in Islam and India" (PDF). Mathematics Magazine. 68 (3): 16374. doi:10.2307/2691411. JSTOR2691411.^ Abdel Haleem, Muhammad A. S. "The Semitic Languages", "Arabic became the language of scholarship in science and philosophy in the 9th century when the translation movement saw concerted work on translations of Greek, Indian, Persian and Chinese, medical, philosophical and scientific texts", p. 811.^ (Boyer 1991, "The Arabic Hegemony" p. 230) "The six cases of equations given above exhaust all possibilities for linear and quadratic equations having positive root. So systematic and exhaustive was al-Khwrizm's exposition that his readers must have had little difficulty in mastering the solutions."^ Gandz and Saloman (1936). "The sources of Khwarizmi's algebra", Osiris i, pp. 26377: "In a sense, Khwarizmi is more entitled to be called "the father of algebra" than Diophantus because Khwarizmi is the first to teach algebra in an elementary form and for its own sake, Diophantus is primarily concerned with the theory of numbers".^ (Boyer 1991, "The Arabic Hegemony" p. 229) "It is not certain just what the terms al-jabr and muqabalah mean, but the usual interpretation is similar to that implied in the translation above. The word al-jabr presumably meant something like "restoration" or "completion" and seems to refer to the transposition of subtracted terms to the other side of an equation; the word muqabalah is said to refer to "reduction" or "balancing" that is, the cancellation of like terms on opposite sides of the equation."^ Rashed, R.; Armstrong, Angela (1994). The Development of Arabic Mathematics. Springer. pp.1112. ISBN978-0-7923-2565-9. OCLC29181926.^ Sesiano, Jacques (1997). "Ab Kmil". 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Contains information on the earliest known uses of terms used in mathematics.Earliest Uses of Various Mathematical Symbols (Jeff Miller). Contains information on the history of mathematical notations.Mathematical Words: Origins and Sources (John Aldrich, University of Southampton) Discusses the origins of the modern mathematical word stock.Biographies of Women Mathematicians (Larry Riddle; Agnes Scott College).Mathematicians of the African Diaspora (Scott W. Williams; University at Buffalo).Notes for MAA minicourse: teaching a course in the history of mathematics. (2009) (V. Frederick Rickey & Victor J. Katz).Ancient Rome: The Odometer Of Vitruv. Pictorial (moving) re-construction of Vitusius' Roman ododmeter.A Bibliography of Collected Works and Correspondence of Mathematicians archive dated 2007/3/17 (Steven W. Rockey; Cornell University Library).International Commission for the History of MathematicsHistoria MathematicaConvergence Archived 2020-09-08 at the Wayback Machine, the Mathematical Association of America's online Math History MagazineHistory of Mathematics Archived 2006-10-04 at the Wayback Machine Math Archives (University of Tennessee, Knoxville)History/Biography The Math Forum (Drexel University)History of Mathematics (Courtright Memorial Library).History of Mathematics Web Sites Archived 2009-05-25 at the Wayback Machine (David Calvis; Baldwin-Wallace College)Historia de las Matemticas (Universidad de La La guna)Histria da Matemtica (Universidade de Coimbra)Using History in Math ClassMathematical Resources: History of Mathematics (Bruno Kevius)History of Mathematics (Roberta Tucci)Retrieved from " Mathematics, the universal language of abstraction and precision, permeates every facet of our lives. But have you ever wondered who first invented this remarkable discipline? While we may never identify a single inventor, the invention of math is a collective endeavor woven into the tapestry of human history. There isnt a single person who invented math. Mathematics, as we know it today, is often perceived as a universal language that transcends cultures and borders. Yet, its essential to recognize that math, like any human endeavor, had its beginnings in the minds of ingenious thinkers from different corners of the world. The concept of math as a human invention underscores its adaptable and evolving nature. Unlike the laws of nature, which exist independently of human cognition, mathematical systems were developed and refined by humans over generations. We didnt just start with the Pythagorean Theorem or quadratic equations. Math started off much, much smaller. The early origins of mathematical knowledge can be traced back to ancient civilizations that thrived thousands of years ago. Mesopotamia, often referred to as the Cradle of Civilization, saw the emergence of some of the earliest mathematical concepts. In this fertile region, ancient mathematicians devised methods for counting and recording numerical information, essential for administrative and economic purposes. Here, Babylonian mathematics was the backbone of ancient Mesopotamian mathematical education. Similarly, the ancient Egyptians made significant contributions to early mathematics, particularly in the realm of geometry. Their mastery of geometry allowed them to survey land, build monumental structures, and calculate areas and volumes with remarkable precision. The ancient Egyptians not only built stunning structures, they were more than capable of comprehending geometric concepts that the rest of the world just wasnt familiar with yet. READ MORE: Ancient Egypt Timeline: Predynastic Period Until the Persian Conquest The Indus Valley Civilization, one of the worlds oldest urban cultures, also made strides in mathematics. Archaeological discoveries suggest the existence of a standardized system of weights and measures, indicating a sophisticated understanding of mathematical principles. So mathematics was not the product of a single individual or culture but a collective endeavor spanning centuries. Early mathematical knowledge was built upon the contributions of countless thinkers and problem solvers, each adding a piece to the puzzle. The Father of Mathematics is none other than the ancient Greek mathematician, Archimedes. Born and raised in the Sicilian city of Syracuse, Archimedes is known for his contributions to mathematics, astronomy, and physics. His developments in math include the Archimedean property, the Archimedes principle, and early precursors to modern calculus. It is not to mention that Archimedes wrote a ton regarding mathematics, though many of these are among personal correspondences with Dositheus of Pelusium, the director of mathematics at Alexandria. READ MORE: Ancient Greece Timeline: Pre-Mycenaean to the Roman Conquest and The Lighthouse of Alexandria: One of the Seven Wonders The invention of mathematics was a response to practical, real-world needs that early societies faced. Understanding why math was invented involves exploring the tangible and essential reasons that drove the development of mathematical concepts. One of the primary reasons for the invention of math was its utility as a problem-solving tool. Early human societies encountered a myriad of challenges, from tracking the movement of celestial bodies to managing resources and conducting trade. Math provided a structured way to address these challenges, enabling civilizations to make predictions, plan, and optimize various aspects of their existence. As you can see, math overlapped with a lot of early scientific ideas. No wonder its such a significant part of STEM. Math was crucial for measurement and quantification, particularly in agriculture and trade. Ancient farmers needed to calculate the area of their fields, determine optimal planting densities, and manage harvests. Similarly, traders and merchants required math to assess the value of goods, establish fair exchange rates, and record transactions accurately. Math is still central to life in todays day and age. Were still out here learning systems of measurement and quantification. Our math teachers were right: math shows up in just about everything. Although it may look different, todays math of today is the product of thousands of years of human collaboration. Architecture and construction were areas where math played a pivotal role. Cultures such as the Egyptians and Greeks used mathematical principles to design and build structures that still awe us today. It may not look like much at a passing glance, but ancient construction required rigorous mathematics. From the precision of the Great Pyramids dimensions to the symmetry of Greek temples, math was at the core of architectural innovation. Observing the heavens and understanding celestial phenomena was crucial for early societies. Math enabled astronomers to predict celestial events like eclipses, track the movements of planets, and create calendars for agricultural and religious purposes. The mathematical achievements in astronomy laid the foundation for modern astronomy and space exploration. In the Age of Exploration, math became an essential tool for navigation. Sailors used trigonometry to calculate their positions at sea, plot accurate maps, and explore uncharted territories. Without mathematical advancements, the great voyages of discovery would have been significantly more challenging. Math allowed for the systematic recording and organization of empirical knowledge. From recording the growth of crops to tracking the positions of stars, math provided a framework to make sense of the world. It transformed empirical observations into structured data that could be analyzed and used for future planning. The complex analysis demanded by mathematics eventually gave way to the Scientific Revolution, which encouraged the emergence of modern sciences. In essence, math was invented because it offered practical solutions to complex problems encountered by ancient civilizations. Its development was closely intertwined with the progress of human societies, enabling them to thrive, expand, and evolve. The utilitarian nature of math, rooted in the real needs of the time, played a pivotal role in its invention and subsequent advancement. In short, math made things make sense and made ancient life easy-peasy lemon-squeezy (sort of). The invention of mathematics is a journey that spans millennia, with its origins lost in the depths of prehistory. Pinpointing an exact moment or a single civilization where math was first conceived is challenging, but through the study of historical artifacts and texts, we can trace an approximate timeline of maths development. Math, in its most rudimentary form, began with early humans. Archaeological findings reveal evidence of basic counting systems dating back tens of thousands of years. These early numeration systems were essential for tasks such as counting possessions, making sense of natural phenomena, and tracking the passage of time. Most folks started counting on their fingers and then went from there. READ MORE: How Long Have Humans Existed? The historical record offers some of the earliest written evidence of mathematical thought in ancient Mesopotamia. The Sumerians, who inhabited this region, developed cuneiform symbols to represent numbers and used math for administrative and economic purposes. Clay tablets from this era contain mathematical tables and problems that reflect some of the earliest mathematical texts. READ MORE: Who Invented Numbers? Unraveling the Origins of Numerical System Most impressively, the notational system in Babylon, with its famous Babylonian mathematics, had the ability to represent fractions with ease. They had extensive experience with quadratic and cubic equations, calculus, and algebra. Modern mathematics still relies on these early mathematical advancements today. Egyptian civilization also contributed significantly to the early development of math. Hieroglyphic inscriptions show that they had a sophisticated understanding of geometry, which they used for land surveying, construction, and taxation. The Rhind Mathematical Papyrus, dating to around 1650 BCE, is a notable example of Egyptian mathematics. Much like the Mesopotamians, the ancient Egyptians have among the oldest surviving mathematical documents in all of math history. Indian mathematicians made substantial contributions to mathematical thought, particularly in the realms of number theory and algebra. The ancient text known as the Bakhshali Manuscript, dated between the 2nd and 3rd centuries CE but containing older material, provides insights into early Indian mathematical ideas. Hallmarks of Indian mathematics include the concept of zero as a number, algebra, and arithmetic. Moreover, they had their own geometric concepts, which were unique compared to that of which is seen in Greek mathematics and later analytical geometry. The Greeks, with their philosophical and deductive approach, laid the foundations of formal mathematics. Examples of pre-Greek mathematics reveal the use of inductive reasoning rather than the deductive reasoning used by the Greeks in math history. Figures like Pythagoras and Euclid made profound contributions to geometry and number theory. Euclids Elements, written around 300 BCE, is a landmark work that influenced mathematical thought for centuries. Meanwhile, Pythagoras is the namesake of many contemporary mathematical terms, such as the Pythagorean Theorem and Pythagorean triples. Euclid himself became known in history as the Father of Geometry for his contributions to the Theory of Proportions and Euclidean geometry. Generally, Euclidean geometry is known as the study of geometric shapes and figures based on different axioms and theorems. Later scholars, such as Omar Khayyam of the Islamic Golden Age, would study Euclids works and find perceived errors in its contents, such as the controversial parallel postulate. During the Islamic Golden Age, scholars in the Islamic world preserved and expanded upon the mathematical knowledge of earlier civilizations. Notable figures like Al-Khwarizmi, the Father of Algebra, and Omar Khayyam, known for his contributions to algebra and geometry, played pivotal roles in advancing mathematics. They expanded upon geometric concepts and various algorithms of the aforementioned civilizations. The development of mathematics was a gradual process that unfolded over thousands of years, with different cultures contributing to its growth. While specific dates and milestones mark key moments in mathematical history, its important to recognize that math evolved organically and was a collective effort shaped by countless individuals and cultures. The invention of mathematics is a testament to humanitys insatiable curiosity and capacity for intellectual exploration. There is no single location responsible for the invention of math. The invention and evolution of mathematics were not confined to a single region but unfolded in diverse geographical locations across the globe. Each of these regions contributed unique insights and perspectives to the development of mathematical knowledge. In short, math wasnt isolated to a single country or region: it was, and always has been a global sensation. Mesopotamia: Located in the fertile crescent between the Tigris and Euphrates rivers, Mesopotamia is often regarded as one of the cradles of civilization. It was here that early mathematical concepts like numerical notation and basic arithmetic operations emerged. The Sumerians, Akkadians, and Babylonians in this region made significant contributions to early mathematics. Egypt: Along the banks of the Nile River, ancient Egypt nurtured its mathematical traditions. The need for precise measurements and calculations to build grand structures like the pyramids fueled the development of geometry in this region. Egyptian mathematics also played a crucial role in agriculture and land management. India: The Indian subcontinent is home to a rich mathematical heritage dating back thousands of years. Ancient Indian mathematicians made pioneering contributions to number theory, algebra, and geometry. Their texts, including the Bakhshali Manuscript and the works of scholars like Brahmagupta, who wrote the Brhmasphuasiddhnta, continue to influence mathematical thought. Greece: The birthplace of classical mathematics, ancient Greece was a hub of intellectual activity. Greek mathematicians like Pythagoras, Euclid, and Archimedes laid the foundations for geometry, number theory, and mathematical proofs. Their rigorous approach to mathematics had a profound and lasting impact on the field. China: Ancient China boasts a long history of mathematical discoveries, with its earliest known mathematical texts dating back to around 300 BCE. Chinese mathematicians excelled in areas such as algebra, geometry, and number theory. Chinese mathematics included a complex decimal system, in addition to the concept of negative numbers by 200 BCE. Their contributions influenced both Asian and Western mathematical traditions. The Islamic World: During the Islamic Golden Age, the Middle East and North Africa became centers of mathematical scholarship. Scholars like Al-Khwarizmi, Al-Kindi, and Omar Khayyam made significant advancements in algebra, trigonometry, and geometry. Islamic mathematicians preserved and expanded upon the mathematical knowledge of earlier civilizations, like the ancient Greeks and Indians. Mesoamerica: In the pre-Columbian Americas, civilizations like the Maya and Aztecs developed complex mathematical systems. The Maya, for instance, created a sophisticated calendar system that involved advanced mathematical calculations. These mathematical traditions were intertwined with astronomy and timekeeping. Meanwhile, the Aztecs developed a base-20 system, along with their own unique symbols used to track these numbers. Each of these geographical regions fostered unique mathematical developments, often driven by the specific needs and challenges faced by their respective cultures. Honestly, the global diversity of mathematical inventions underscores the universal nature of human curiosity. Humans have the capacity to create and refine mathematical concepts, regardless of geographical boundaries, and thats pretty astounding if you ask us. The invention of math took years in the making! It was not solely about discovering numerical relationships; it also entailed the development of systematic methods, notations, and philosophical underpinnings. Understanding how math was invented involves delving into the processes and intellectual endeavors of early mathematicians. Early mathematicians employed empirical observation and trial-and-error methods to make mathematical discoveries. They engaged in practical problem-solving, seeking solutions to real-world challenges such as trade, agriculture, and construction. Over time, these practical observations led to the formulation of general mathematical principles. The development of mathematical notation was a crucial step in the evolution of math. Numerical symbols and written representations of mathematical concepts allowed for the communication and preservation of mathematical knowledge. Different cultures devised various systems of notation. Eventually, symbols and notations became standardized. Geometry played a central role in the early development of math. Ancient cultures like the Egyptians and Greeks applied geometric principles to land surveying, architecture, and astronomy. Geometry provided a visual and practical foundation for mathematical understanding. The invention of number systems was fundamental to mathematical progress. Various cultures developed their respective numbering systems, including base-10, base-60, and base-20 systems. These numerical systems facilitated counting, calculations, and record-keeping. These many number systems continue to influence our modern mathematics. The philosophical underpinnings of mathematics also played a significant role in its invention. Greek mathematicians, for example, sought to establish rigorous proofs and logical reasoning in mathematics. The idea of axioms and deductive reasoning laid the groundwork for modern mathematical rigor. READ MORE: Historys Most Famous Philosophers: Socrates, Plato, Aristotle, and More! As cultures interacted through trade and conquest, mathematical ideas and knowledge were exchanged and merged. Societies are going to socialize, after all. The Silk Road, for instance, facilitated the exchange of mathematical concepts between the East and West. This cross-cultural fertilization enriched mathematical thought and led to new discoveries. The documentation and preservation of mathematical knowledge in written texts were crucial for its dissemination. Ancient texts, inscriptions, and manuscripts played a pivotal role in transmitting mathematical ideas from one generation to the next. As with most ancient history, the presence of a written text is vital to its survival. The invention of mathematics was a dynamic process that integrated practical needs with intellectual curiosity and cultural exchange. It involved the gradual refinement of methods, notation, and philosophical frameworks. Thus, mathematics transcends mere counting and measurement to become a universal language of abstraction and problem-solving. The collaboration of early mathematicians, driven by the challenges of their times, continues to shape the mathematical landscape we know today. The Scientific Revolution of the 16th and 17th centuries had a massive impact on the mathematical and scientific ideas of the Early Modern Period. During this time, the Greek approach to science and math, as established centuries ago by Greek mathematicians, was replaced. New polymaths flocked to the limelight provided by the scientific upheaval, garnering respect in their field for countless discoveries and contributions. Key figures of the Scientific Revolution include Sir Isaac Newton, Galileo Galilei, Ren Descartes (who contributed greatly to analytic geometry), and Johannes Kepler. The invention of mathematics is a testament to the ingenuity of human civilizations across the ages. It emerged organically as a response to practical needs, evolving through diverse cultures and regions. While we may never pinpoint a singular inventor, mathematics stands as a collective achievement, enriched by countless contributions. Mathematics enduring importance in fields ranging from science to economics underscores its vital role in shaping our modern world. The collaborative and cumulative nature of mathematical development reminds us that the quest for knowledge transcends boundaries and remains an enduring hallmark of human progress.

When was the first math discovered. When did mathematics begin. When was the first math equation. Math invented or discovered. When did math first start. When was the first math problem.