Teacher info ▼ Learn the names for angles of all sizes CCSS.MATH.CONTENT.4.G.A.1Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. LTI launch URL (help) Teacher info ▼ Lines that never, ever cross CCSS.MATH.CONTENT.4.G.A.1Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. CCSS.MATH.CONTENT.HSG.CO.A.1Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc. LTI launch URL (help) Reddit and its partners use cookies and similar technologies to provide you with a better experience. By accepting all cookies, you agree to our use of cookies to deliver and maintain our services and site, improve the quality of Reddit, personalize Reddit content and advertising, and measure the effectiveness of advertising. By rejecting non-essential cookies, Reddit may still use certain cookies to ensure the proper functionality of our platform. For more information, please see our Cookie Notice and our Privacy Policy. Are you on the lookout for a complete online course to master the essentials of Geometry? Look no further! Our course is designed to guide you through every concept, from the basics of shapes and sizes to the complexities of theorems and proofs. Whether you're starting fresh or brushing up on your knowledge, this is the perfect resource for all your Geometry learning needs! If you want to take a completely free course that includes all you need to do well on the Geometry test, then this course is the one that will teach you every needed concept before the test date. It's ideal for your needs and covers every Geometry concept. This Geometry program as well as additional Effortless Math Education products gets utilized by multiple people taking the Geometry exam annually. It helps them review basic math info, as well as find out if they need to study more in certain math concepts. With it, you'll get your best possible score on a Geometry examination. Learn it all at your own speed, since there's no required schedule! The lessons all include examples, special activities, notes, and practice sessions so you'll totally understand it and learn all you need to know. The Absolute Best Book to Ace Geometry $29.99 Original price was: $29.99.$19.99Current price is: $19.99. Looking for the best resource to help you succeed on the Geometry test? The Absolute Best Book to Ace the Geometry by: Arezoo about 2 years ago (category: Blog, Online Math Courses) 1 year ago Related to This Article More math articles Learn Geometry Lessons Online DISCLOSURE: This post may contain affiliate links, meaning when you click the links and make a purchase, we receive a commission. Geometry is a vital part of learning Maths and it is considered one of the most difficult segments of mathematics. There is algebra that requires a lot of mental exercise and the complex equations make it difficult. However, Geometry makes algebra look like a piece of cake. With geometry you don't only have to deal with complex equations but there are also some highly complex figures and graphs involved. All these things make Geometry a nightmare for most students and they try to avoid it as much as possible.Learning Geometry can also be fun for those who are able to understand it properly and learn it in interactive ways. Geometry is considered a subject in most educational system and special attention is paid towards it. However, students still find it boring and complex to understand. For teachers in class it is hard to keep students' interest in the subject. If you are one of the students who felt Geometry boring in the class and want to learn it properly so you can understand the fundamentals of or to get an A grade in your next Geometry exam, there are some websites that provide help for your learning journey. These websites can help you learn Geometry in no time at all and that too online. You can read about a few websites here:14 Websites to Learn Geometry Lessons Online Reviews 1) UdemyUdemy is considered the largest platform in the world of online learning. The reason is pretty obvious, they got the largest library with thousands on courses available on their website. Whatever you can think of to learn online, Udemy got a solution for you listed on their website and you can manage them all under one place. They do not charge you any subscription fees, and all you have to pay is a minimal fee for the course you want to learn. Once you have paid for the course, you will get indefinite access to it and it will be added to your account.There are hundreds of courses on Geometry listed on Udemy.com. Whether you want a course for yourself, for your kids or to get through the high school exams. Udemy is the place for you to get the best Geometry courses. These courses present you with the right opportunity to learn Geometry with no bells and whistles and straightforward approach that will help you meet your goal of learning Geometry online. The website is a heaven for those who are into online learning and prefer it over traditional learning methods as the course choice is not limited and you got multiple options according to your preference and needs . 2) LyndaLinkedIn is one of the most popular platforms these days. It is sort of a corporate social media that allows you to connect with organizations and professionals in your relevant field across the globe. Contacts matter in corporate world and the right contact can land you your next perfect job. However, contacts are not all and you need to have relevant skills too to ensure that you are eligible to move forward in your career.For those who never cease to learn and stop at nothing, LinkedIn has introduced its own platform for online learning named Lynda. This is a highly engaging platform that can help you learn online all the skills you want. There are some great geometry lessons listed on the website that can help you grow professionally. These geometry lessons are available along with hundreds of other topics. Lynda.com offers a one-month free trial that will allow you access to thousands of courses. After that you have to pay a nominal monthly subscription to access to all these courses. 3) edXedX.org is about online education on most taught subjects around the globe. You can find websites on the internet that are available for skilled based courses or other courses that are extracurricular. However, edX focuses more on the educational part of the industry and brings out some of the best courses on educational topics and subjects. The website has an interactive interface that makes things easier for even beginners and everyone can find the right way on this website easily. There are also some highly insightful materials that can help you along with the courses listed on this website.edX.org has been helping people learn Geometry across the world. Thousands of students are enrolled with these courses available on their website. There are also some highly informative and easy to understand courses listed online that are from prominent institutions across the world. You can find some of the best courses and making the website popular. A fair share of this popularity goes to the partner institutions that play key role in organizing the structure of these online courses that are listed on the website. 4) PreplyWhat other way would be perfect than to learn geometry from a website that is dedicated to help students prepare f or their exams online. Preply started as website that can help you with getting the right grades in your exams. Now, it has grown into a large platform that provides you access to multiple courses and that too online. There are thousands of courses in Preply library that can be the right assistance for you if you are looking to prepare for your exams online or to learn a new skill.The website offers some really cool crash courses on Geometry that you can take in a day and feel yourself confident before taking your next geometry exam.Preply has hundreds of courses on Geometry listed on the website that can get you up and going in as short as one day and you can sit in your geometry exam confidently. The courses on Preply are structured in accordance to the educational system of most universities and you can get access to some top professionals on the website from across the world to accompany you on your geometry learning journey. These teachers will charge you for per hour if you want personalized sessions or you can take advantage of their online published courses. 5) SkillShareSkill Share is not about making profits but helping other people learn. While other websites have centralized course material that they own and control, Skill share provides an equal opportunity for all those who are good at some skill to help others learn from it and get their fair share of earnings. There course on Skill Share.com are uploaded by the experts themselves and you can ask for guidance wherever you find yourself in a fix.You can find a great many courses on Geometry listed on the website from some of the most popular and experienced mathematics teachers and Geometry experts. The courses are of different difficulty levels and are categorized into several classes that you can choose from according to your needs and convenience. The best part about SkillShare.com is that you won't need to pay for each course. You will only pay for a monthly subscription and you can get access to all the courses you want including some top courses on Geometry. This method suits all those who like to learn multiple things online and don't want to spend hefty amounts on buying separate expensive courses for each subject. 6) TakeLessonsTake Lessons is another non-traditional online learning website that does not push you to learn from certain pre-recorded lessons. They have introduced the right and most people seem it as perfect method to help students learn any skill they want. They provide you with access to experienced teachers online that can help you with any sort of learning problems you are facing.There are some highly experienced teachers available on the website that can help you with geometry. The best thing about this website is that you will not have to pay for subscription and only pay for the time you will spend with your instructor to learn and move further. The website offers you a choice to select the tutor of your choice that suits your language, learning level, and timing the best. After that, you can decide on a time that mutually suits you both and start taking one-on-one lessons from your teacher online. 7) LessonfaceAs the name suggests, this website gives face to the online lessons. While you can find thousands of course on the internet, you are never sure about the authenticity, or you get problems with understanding the narrative or concept of the topics that are being taught in those courses online. Lesson face is one of the largest problems with such courses and you can find it hard to understand if you are in USA and you find a course from some Russian teacher. No matter how informative and helpful the course is, it will not work for you because you are having the accent issues.Lesson Face solves this problem for you as they provide you access to numerous online teachers that can help you learn in one-on-one sessions. There are teachers from all over the world listed on this website that will not only be a great help for your learning experience but you can proactively ask them for any confusions and learn what you want from these teachers. Its just like having private tutor but online. 8) StudyStudy.com is another highly interactive website that covers most major subjects that one can think of. This website is much more than simple video lessons that can help you with learning geometry. There are crash courses on geometry that can help you prepare for your next exam like flash. Also, there are some great ways listed on the website that will help you improving your credit hours. These online classes will add your credit hours on your enrolled degree program. The website is also offering some highly engaging nano-degree programs online that you can take easily and groom yourself. There are separate logins for teachers, schools, students enrolled with the partner schools and universities and those who want to learn geometry online. All the content listed on this website on Geometry courses is approved from most renowned universities across the globe and they never compromise on quality education. You can find help with High school stuff to advanced geometry on this website easily. 9) ReedReed.co.uk is another great website that is known for its vast library that has thousands of courses listed online. This website offers you access to these courses without having to pay any membership fees at all. All you will need is to sign-up for free on the website and buy the course you want to learn from. These courses are impeccable in terms of quality and you can be rest assured that due to huge variety of the courses available online, you are certainly going to get the course on geometry you are looking for.The courses on geometry range from beginner to advanced level and they have got a solution for all ages. These courses are a right help for you to get assistance on your geometry learning journey online.Reed.co.uk is a UK based website and accepts GBP so it is more convenient for the residents of UK or European countries. The courses on Geometry that are listed on this website go through high-quality checks that ensure that only best content is being uploaded on the website that will help students in their learning journey. 10) AlisonAlison.com is an online educational website with multiple perks and no complications. These courses are straight to the point and are developed in-house. That means, you can expect the highest level of quality for these courses. While other websites are focused on quantity, this unique and interactive website prefers quality and only published the top-notch content on their website. There are fewer categories compared to other websites but you can get access to crash courses, certificate courses and also get some highly insightful learning paths to move forward with your career.The geometry courses listed on the website are of high quality standards and meet the requirements of most educational institutes. So, if you are looking to get a course on geometry to help you with your academic progress, this is the perfect website for you. 11) UniversalclassThink of a class that has students from all over the world and you get to learn from them while getting educational guidance from a teacher. Universal class has made the concept virtual and with their help you can get enrolled in one of such class where students are joining from all over the world. These online classes are just like regular classes where you can understand directly, ask questions from the teacher of even interact with other students but online.The website offers you to get enrolled with one of these programs and get your place in the online class. There are pre-set number of lessons and they also give you assignments and make you take the exams at the end of the course to ensure your learning level achieved from this class. Thousands of students have happily completed their geometry learning journey on the website. The course is CEU certified and adds around 1.7 CEU to your profile as well. 12) MathhelpMathhelp.com is a dedicated website to help students who are weak at math grow exceptionally and make progress in the subject. The website serves as the right aid for those who find math boring and dry subject. It is hard to concentrate in a maths class and that is a universal fact. A very few students find math interesting and it is mostly due to the teaching methods are not engaging enough for all students to understand and interpret what is being delivered.This website solves the problem for you and brings out some of the highly innovative and engaging ideas to keep students' interest and help them grown their math skills and knowledge. If you are looking for geometry help online, the website has a dedicated section for you that covers all the major concepts and fundamentals of geometry that will aid you significantly in grasping the context and you will never feel bored in the maths class again. These geometry courses, exercises and creative quizzes will enable you to keep your interest in the subject being taught and you will start loving the subject without realizing it. 13) BasicMathematicsBasic Mathematics.com is a free online website that helps students to grasp basic context and concepts of maths in creative manner. The website takes assistance from engaging resources like videos, animations and more to enable you understand maths easily and conveniently at your own pace. This website is a right website for most kids that are from Montessori to high-school level as the course material and learning perspective focuses on the fundamentals of maths. These course materials comply to most educational institutions and schools around the US. To top it all, these resources on website are absolutely free. Basicmathematics covers an elaborate range of geometry concepts and these courses can help you cover all the topics that you might need to get over before your next school exam. These courses come with an exercise and quiz that will help you test your knowledge as well. 14) ClassCentralOnline learning is all about cutting the restrictions and having lots of choices unlike a school or an institution that only teaches their own curriculum. However, to find a website that do not implies restrictions on you can be hard. Although, there are websites that have a huge library of courses on each subject. Yet, they lack the freedom of choice in a manner that if you like to get an online course from some other website, you will have to pay for their subscription.Class Central follows a unique and independent approach that cuts these things and provide you with the right opportunity to not have to choose between courses of one website or another. They have centralized the content and course materials from most major online learning platforms that you can take advantage from and learn from the very best at your own terms. The website cuts all the restrictions and you can get access to whichever course you want from any of the online learning websites. There are some highly insightful courses available on the website that range from beginner to advanced level. These courses are covering most major aspects of Geometry and allow you freedom of choice. Choosing the Best Geometry Lesson OnlineWithout interest, maths can be the most boring subject in the world and you are constantly looking your ways around it. However, the issue most students are facing is with the information delivery methods of teachers. To make things interesting, informative and innovative for you, you can get help from these great websites that can help you learn geometry in no time at all, while sitting at your home. We have reviewed some of the top websites that you can choose from, for your online geometry learning journey. A great variety of free geometry lessons along with geometry worksheets and calculators. First start studying the prerequisites. Geometry and Problem Solving Types of Angles Polygons Perimeter and Area Circles Volume and Surface Area Congruence and Similarity Geometric Transformations Slope and Linear Equations Pythagorean Theorem Geometry Formulas Analytic Geometry Theorems and Postulates Advanced Geometry Topics Construction and drawing in geometry Goal:Identify basic shapes in geometryFind perimeter and area of shapesFind volume and surface area of solidsFind the standard from of a lineExplore some important proofs in geometry Do you need geometry help with a tutor? Many geometry tutors are available to help you right now with your homework or any question(s) you have. Check this site to chat with a tutor right now. Teacher info ▼ A fancy name for shapes with straight sides CCSS.MATH.CONTENT.2.G.A.1Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces.1 Identify triangles, quadrilaterals, pentagons, hexagons, and cubes. LTI launch URL (help) Yes. There were mathematicians who were in geometry. In fact, anyone who contributed to our understanding of geometry was a mathematician. © 2025 Brilliant Worldwide, Inc., Brilliant and the Brilliant Logo are trademarks of Brilliant Worldwide, Inc. In today's world of technology, where all the kids have access to mobile devices and the internet, learning and studying geometry online can be an engaging and rewarding experience. However, the question to which students are searching for an answer is: How to learn geometry easily? How do you learn it online?Here's a comprehensive guide to help you navigate the world of geometry and help you understand how to learn geometry for beginners.Understanding GeometryGeometry is a branch of mathematics that deals with properties and relationships of points, lines, surfaces, and solids. It is foundational for various fields, including architecture, engineering, and art. Understanding geometry not only enhances mathematical skills but also improves spatial reasoning, which is crucial in everyday decision-making and problem-solving.Why Study Geometry?1. Real-World Applications: Geometry is everywhere, from the architecture of buildings to the design of everyday objects. Understanding geometric principles can enhance your appreciation of the world around you.2. Foundation for Advanced Mathematics: A solid grasp of basic geometry is essential for tackling more complex mathematical concepts in algebra and calculus.3. Career Opportunities: Many professions, including architecture, engineering, and graphic design, require a strong understanding of geometric principles.Tips: How to Learn Geometry for Beginners1. Engage with Visuals: Geometry is inherently visual. Use diagrams and drawings to better understand concepts.2. Practice Regularly: Consistent practice is key. Work on problems daily to reinforce your understanding.3. Utilize Online Tools: Take advantage of interactive tools and apps that make learning geometry fun and engaging.4. Join Study Groups: Collaborate with peers to discuss concepts and solve problems together.5. Seek Help When Needed: Don't hesitate to reach out to instructors or use online forums if you encounter difficulties.Benefits of Learning Geometry Online1. Flexibility and ConvenienceOne of the primary advantages of online learning is the flexibility it provides. Students can access geometry courses anytime and anywhere, allowing them to learn at their own pace. This is particularly beneficial for those who may have busy schedules or prefer to study in a comfortable environment.2. Interactive Learning ToolsOnline platforms often incorporate interactive tools such as videos, simulations, and quizzes that make learning geometry more engaging. These resources help visualize geometric concepts, making it easier to understand relationships between shapes, angles, and dimensions. There are over 100 videos with graphics that are available to make the visualization of 3D shapes easier on Math Me Up.3. Personalized Learning ExperienceOnline geometry courses can be tailored to meet individual learning needs. Many platforms, like Math Me Up, offer personalized lessons that adapt to a student's progress. This customization ensures that learners can focus on areas where they need the most help, whether it's basic principles or more advanced topics.4. Immediate FeedbackOnline learning platforms often include quizzes and assessments that provide immediate feedback. This instant evaluation helps students identify their strengths and weaknesses, allowing them to adjust their study strategies accordingly.In conclusion, learning geometry online provides a flexible and engaging approach to mastering essential concepts. By utilizing resources like Math Me Up, students can access interactive tools and personalized lessons that cater to their individual learning needs. Embrace the opportunity to enhance your geometric understanding and apply these skills in real-world situations! Geometry, dating back to 3000 BC, is that branch of mathematics that helps in giving shape and dimension to the otherwise flat world around us. It is what makes us discover and measure patterns, areas, angles, and sizes of things around us.Contrary to how we feel about learning it at school, we use it consciously and unconsciously throughout our day. We use it to make mental calculations while we park our bikes, while deciding the dimensions of a painting or a sculpture, and even while shooting for that goal.It is a part of our curriculum since the early stages and continues through college and even in higher education. Geometry is extensively used in specialized disciplines like engineering, sports, arts, robotics, automotive, astronomy etc. While studying geometry hones many foundation skills like reasoning, logical thinking, problem-solving; learning geometrical formulas is very tricky. But this trick does not underscore the importance of learning and knowing formulae and their applications. Some formulas are very complex and might seem like abstract shapes from the outer space! The question is how to memorize formulas and remember them for life?So, here are some few tips - 1. Make Math & Geometry fun and develop a mindset for it The first and foremost step is to stop demonizing geometry and letting go of all the mental baggage of thinking it to be difficult to study. Think of it, as an ally for anything to what you will pursue in your life. Keeping an open mind for geometry will make it seem easier and friendlier. 2. Understand and not cram You can easily forget what you crammed, but never what you truly understand. Instead of having a myopic focus on the numbers and symbols, try to understand what that particular formula actually solves. Once you have a semblance of a real world issue being solved by a formula, you are unlikely to forget it ever in your life. 3. Be creative Instead of cramming up a formula, think and devise ways, which interest you and are sure to sustain. Visual aids have been proven to be more comprehensible and retentive especially when it comes to remembering and recalling numbers and symbols. You can make Flashcards, Sticky notes & worksheets, watch videos, say them aloud, quiz yourself, and have a friend or teacher recite them with. These are some of the ways, which have been known to help a lot of students. Another interesting technique is to use mnemonics- create an interesting story that sequentially involves the formula that you are trying to learn. Recalling the story is an easy way of remembering the formula. 4. Set your goal Seeing yourself in an important position in the world of mathematics gives positive reinforcement to your drive to learn. Whether you are studying or planning to contribute to the greater body of mathematical knowledge, you cannot do without knowing the correct formulae. Students, Mathematicians, and Geometricians actually spend a lot of time in mathematical writing especially research papers. Writing research papers helps in developing one's comprehensive communication and the ability to explain your mathematical ideas and thinking process. Sometimes, it's difficult to understand when someone says "write me a research paper"; however, for such occasions only, there are many websites that can help you find the right context of writing research papers. 5. Stay away from distractions Set aside distraction free learning time. When you are memorizing something to do with numbers and symbols, it is easy to get bored and sway towards distractions. Avoid wasting your time taking too many breaks, surfing the Internet, and texting your friends. 6. Get some sleep A lot of students think that cramming for long hours will help them in learning. This statement could not be further away from the truth. Relax your body and mind with eight hours of sleep. It will ease and quicken your learning process. 7. Exercise How to remember things easier? Simple. Sport and exercise help in lowering stress and sending oxygen to your brain. Your mental and physical fitness has a direct impact on your learning capabilities especially numbers. A stressed brain learns slowly and does not retain. Walking, jogging, hiking, and yoga are easy ways to get good exercise. These activities also take you away from the monotony of your room or cramped studying space. More sport and you'll forget that you ever struggled with the question of how to learn maths fast.Taking deep breaths also helps in lowering overwhelming and negative feelings. 8. Eat light Being hungry or thirsty while studying is sure to distract you, and you will have a hard time concentrating. To learn and memorize better, keep eating light snacks like fruits etc. and consuming water at regular intervals. So, I hope now you know how to memorize things quickly. Kindly mail your feedback to v4formath@gmail.comWe always appreciate your feedback. ©All rights reserved. onlinemath4all.com Geometry (from the Greek: "earth measurement") is a branch of mathematics concerned with questions of shape, size, the relative position of figures, and the properties of space. Geometry arose independently in several early cultures, but the main question is: Who invented geometry? Euclid, a Greek mathematician, invented geometry. He was born in the city of Alexandria, Egypt around 300 BC. He was educated at Plato's Academy in Athens and taught there for many years. He wrote many books on mathematics and geometry. The truth is, geometry can be traced farther back than we can imagine. So, continue reading this article and you'll discover some amazing details about it. Let's check it together! Also Read: the inventor of the number zero Euclid of Alexandria was a Greek mathematician who invented geometry. He lived around 300 BC, and his work was hugely influential on the development of mathematics as we know it today. In fact, Euclid's Elements is still considered one of the most important mathematical texts of all time. It consists of 13 books that describe geometry in terms of a set of axioms and postulates. After these are established, Euclid then builds up proofs based on them—proofs that have stood the test of time for thousands of years! Euclid's work was so well-known and respected that it became the standard for teaching geometry for over 2000 years. His work on triangles, circles, and other shapes continues to be taught in schools today! Geometry is a branch of mathematics that deals with the properties and relations of points, lines, surfaces, curves, and angles. It is also known as 'the science of space'. In ancient times, people used geometry to measure and calculate distances. They also used it to design buildings and other structures. However, geometry evolved over the centuries. The first geometry was developed by the ancient Greeks. It included only two types of geometry: Euclidean geometry and non-Euclidean geometry (which includes hyperbolic geometry). After that, other types of geometries were invented, including elliptic geometry, projective geometry, and spherical geometry. Euclidean geometry is the most commonly used type of geometry. It is based on five postulates and a small set of axioms, with which it can be proven that all figures in a Euclidean plane are contained within a finite number of lines (or points). Euclidean geometry is named after its founder, Euclid, who wrote his Elements around 300 BC. This was an attempt to compile all of the known knowledge at the time into a single document. It has been used throughout history by mathematicians, astronomers, and engineers to create models for things such as bridges and buildings. Analytic geometry is a type of geometry where we use algebra to describe geometric figures. Descartes and Fermat are the ones who invented analytic geometry in the 1630s. In this type of geometry, we use algebraic formulas to find lengths, areas, and volumes of geometric figures. The formulas can be solved by using coordinate systems or by using a Cartesian coordinate system. This type of geometry makes it easier to solve problems related to triangles, quadrilaterals, and circles because we do not need to use trigonometry or other advanced mathematics techniques. Benoit Mandelbrot defined fractal geometry. He first applied his theory to clouds and other natural phenomena, but then he realized that it could be used for computer-generated art as well. Fractal geometry is a type of geometry that uses fractals to create new shapes. Fractals are mathematical objects that are self-similar, meaning that they contain smaller versions of themselves within them. The most famous example of this is the Mandelbrot set, which is made up of an infinite number of repeating shapes that look similar but differ slightly in size and position. Hyperbolic geometry is a branch of geometry that evolved from Euclidean geometry. In hyperbolic geometry, the sum of the angles in a triangle doesn't equal 180 degrees. So if you were to draw a triangle on a piece of paper, then look at it under a microscope, you would see that there is no way for all three sides to be straight lines. This is because hyperbolic geometry uses "hyperbolic lines," which are curved like the surface of a saddle or sphere, instead of straight lines. This makes hyperbolic geometry different from Euclidean geometry, where all lines are straight and obey certain rules about how they can be connected together. Abstract geometry is a type of geometry that focuses on creating a visually pleasing image rather than being mathematically precise. It was popularized by the Dutch painter Piet Mondrian. This form of geometry is abstract because it doesn't try to describe real-world objects or phenomena. Instead, its focus is on the study of shapes and spatial relationships in abstract terms. The relationship between two points is considered to be an entity on its own, separate from any other entities or concepts. Mondrian believed that art should accurately reflect reality, but he also believed that artists should not be constrained by the rules of perspective or even by any particular medium (such as paint). Sacred geometry evolved from 2000 BCE to 1000 BCE in Egyptian and Greek cultures, and is based on the idea that God created the universe using a set of geometric shapes. It's believed that these shapes can be found throughout nature, and are used as symbols for things like life and death. Sacred geometry is used in art and architecture as well as science. The most famous example of sacred geometry is the Flower of Life, a pattern made up of seven polygons arranged in such a way that they create a flower-like shape. This pattern can be found all over the world, from ancient Egypt to ancient Greece, to modern-day Native American cultures. Carl Friedrich Gauss and Gaspard Monge defined differential geometry at the beginning of the 19th century. It is often defined as "the study of curves, surfaces, and other geometric objects" from a different point of view – namely, their local properties. This means that instead of looking at objects from afar, like we do when we look at a sphere or a cube, we look at them up close and examine how they differ from place to place. Differential geometry has applications in many fields including mathematics, physics, engineering, chemistry, and biology. In the year 1851, Joseph Huddart defined the geometry box. He was a British inventor and engineer who lived from 1821 to 1901. He was known for his many inventions, including the steam engine and the steam turbine, as well as his work on metallurgy. The geometry box is a device that helps people construct geometric shapes, like triangles or squares. It has two rods that can be moved up and down, so you can adjust the length of each side of your shape. Geometry dash is a mobile game created by Sweden-based developer Robert Topala. The game was released on the Google Play Store in October 2013, and it quickly gained popularity. It was downloaded more than 10 million times within 24 hours of its release, and more than 100 million times within the first month of release. Geometry dash features a wide variety of levels and game modes, as well as a level editor that allows users to create their own levels and share them with others. The geometry compass was invented by Galileo Galilei in Padua in 1597 and built by Marcantonio Mazzoleni. The geometry compass is a device used to draw circles and arcs, which are essential in geometry. The invention of the geometry compass led to an increase in the popularity of geometry and trigonometry, as well as other subjects that use these tools. Galileo Galilei designed it to be used for drawing circles and straight lines, and he built it with a long, straight body that can be adjusted to different lengths. The compass needle is mounted on a ring that can be moved around the body of the instrument. Euclid of Alexandria is often mentioned as a man who is the father of geometry. However, there is no evidence that he was born in Alexandria, or that he even existed. The first mention of Euclid comes from Pappus of Alexandria, who lived around 300 AD. The Elements was written by Euclid around 300 BC, and it became the standard textbook for geometry for over 2000 years. The book contained 13 books on Euclidean geometry, which included many common geometric shapes like triangles and circles. So, when was geometry first invented? Geometry was invented around 300 BCE by Euclid, although it's hard to pinpoint exactly when. It was a part of the ancient Greeks' math system and was used in architecture, astronomy, and engineering—all fields that required accurate measurements. The word geometry comes from Greek: γεωμέτρης (geōmetris), meaning "earth-measurer". Geometry began in ancient Egypt, where it was used to build pyramids and other structures. Knowledge of geometry was passed on to ancient Greece and India, then later to Islamic scholars. It was used in medieval Europe as early as 1120 CE. By the 18th century, geometry had been extended to three dimensions with the addition of analytic geometry Today geometry is a branch of mathematics that is used in almost every field of science and technology. Many people are wondering why was geometry invented. The first attempts at geometry definitions are visible in some early cultures as a body of practical knowledge. It emerged in Ancient Babylon and spread across Ancient Egypt. Later on, Indian mathematicians and traders tried to define the geometry and their attempts were supported by Chinese scientists and silk road traders. Finally, Euclid defined geometry around 300 BC. Geometry has applications in many fields, including art, architecture, physics (especially quantum mechanics), engineering, robotics, and computer graphics. Angles in math are identified by Euclid. Euclid is the greatest mathematician of all time, who wrote a geometry book. He defined the term angle as "the inclination to one another of two lines in a plane which meet one another and do not lie straight with each other." The first thing about angles Euclid identified is that an angle has to be measured between two lines that meet at a point. The first type of solid shapes to be discovered are known as Platonic solids. They were named after the Greek philosopher Plato, who was famous for his work on geometry. Plato noticed that these five regular polyhedra had many interesting properties in common, including that they could be constructed by rotating a regular triangle in three-dimensional space around one of its vertices. He also noticed that they had extremely important symbolic significance – each of them is made up of exactly five regular polygons, and each has an equal number of edges, faces, and vertices. To bring you closer to geometry, I'm presenting to you the list of basic geometric terms and definitions: Point—A location in space, but not a shape. The points you can see in your room represent the locations of objects and people. Angle—The space between two lines, measured by degrees. Line—A straight path between two points. You can draw lines on paper with a pen or pencil, but they also exist in the real world. For example, the sides of buildings are lines. Parallel—Two lines that are the same distance apart and never intersect, no matter how far you go along them. Vertex—The point where two lines meet or the point where a line crosses another line or surface at a right angle. Congruent—Two geometric figures are congruent if they have the same size and shape. Perpendicular—Two lines, rays, or planes are perpendicular if they meet at a right angle. Two-dimensional shape—A shape that exists in two dimensions is a flat surface with length and width but not depth. Examples include squares, rectangles, triangles, circles, and hexagons. Three-dimensional shape—A shape that exists in three dimensions: length, width, and depth. Examples include cubes and spheres. The history of geometry is a long and storied one, dating back thousands of years. It has been used by mathematicians, philosophers, builders, and artists for centuries, and it continues to be relevant in contemporary times. Therefore, I'm presenting to you the history of geometry timeline: 2500 BC – Construction of Egyptian Pyramids. Pyramids are some of the oldest structures in the world, and they were built using a complex understanding of geometry. 2000 BC – A Greek mathematician called Heron (or Hero) invented what is now known as Heron's Formula, which describes how to find an unknown side length when two triangles are similar. 600 BC – Another Greek mathematician named Pythagoras discovered a number pattern called Pythagorean Triples. This pattern can be used to find lengths or areas of right triangles using only whole numbers. 300 BC – Euclid invented geometry and is known as the father of geometry. He wrote several books on the subject and his most famous work, Elements, is still studied today. 200 BC – Archimedes discovered a formula to calculate the volume of cylinders which were not round but had flat sides like pyramids or cones. Here's a list of the most frequently asked questions about who invented geometry and how geometry shaped the world we live in today. Euclid was a Greek mathematician who lived in Alexandria, Egypt around 300 BC. He is considered the father of geometry because he created the geometry that people do today. Euclid created Greek geometry. He wrote the book Elements, which contains all of the main concepts in geometry, and introduced them to the world. His most famous work is Elements, which is a textbook on geometry in 13 books, first published around 300 BC The concept of geometry was discovered and developed throughout the centuries. The word "geometry" comes from the Greek word geometria, meaning "earth measures". To sum it up, different cultures around the world contributed to the development of geometry. The Babylonians, Indians, Chinese, Egyptians, and Arabs all helped lay the foundations of geometry. Then later on Greeks such as Euclid, plus Apollonius, Archimedes and others did advanced methods to draw new figures. So, all of them can be credited as people who invented geometry. The point is, the world we live in today wouldn't exist if geometry wasn't invented. So, if you want to discuss more about it, feel free to leave a comment and I'll respond shortly. Teacher info ▼ Find the distance around a circle (and then eat some pi) CCSS.MATH.CONTENT.7.G.B.4Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle. CCSS.MATH.CONTENT.HSG.GMD.A.1Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments. LTI launch URL (help) Chat with our AI personalitiesViviYour ride-or-die bestie who's seen you through every high and low.What smells deter bears?Why are there craters on the moon?Ask a question and get an instant answerFormula for a joule? Asked by AnonymousWho is the artist of polka dot bikini girrl? Asked by Anonymous The first rule of life? Life (as well as geometry) can be difficult. But why make it more difficult than it has to be? Do you need help with geometry? Here are 11 tried-and-true tips to make your forays into the world of geometry as painless as possible. 1. Use a clear plastic protractor. Tools are fun, and the dandy protractor is no exception. The clear plastic kind is especially handy because you can see through it. That way, you can extend your angles right through the scale of the protractor. Reading angle measures is much easier then. 2. Use a clear plastic ruler with inches and centimeters. Just as with a clear plastic protractor, with a clear plastic ruler, you can extend your lines, which makes getting their measures easier. Using a ruler with inches and centimeters is a good idea. Go metric, baby! 3. Buy thyself a compass. You need to have a protractor for your angles and a ruler for your straight lines. You also need a compass — for those curved lines. Look for one that has a ruler right on it. That way, you don't have to use both the compass and a separate flat ruler when making a circle. Just pull the compass apart the distance you want and use the built-in ruler. 4. Get a good pencil to draw fine lines. You need a pencil to make accurate drawings. Try to find a technical drawing pencil with a .05 mm lead. An eraser is an important commodity, also. You won't regret getting one that has a brush. Eraser residue leaves the page easier when it's brushed away. 5. Buy thyself a good scientific calculator. Never underestimate the power of a good scientific calculator — the kind with sin, cos, and tan keys. You're going to need those keys on trig days. Square root and squared keys are useful for all that triangle stuff. And fresh batteries are a good idea on test day. 6. Write down your givens and wants. When you're setting up to solve a problem, be it a proof or just an equation, write down everything you're given to work with even if it doesn't seem important. The smallest details can lead to the biggest revelations. After you finish with what you've been given, move on to what you want. Write that down, too. 7. Make diagrams. A picture is worth a thousand words. Make a diagram with your awesome technical pencil. Try to draw things in proportion, keeping your spatial relationships intact. Mark off everything in the drawing that is in your given. If you have congruent lines, congruent angles, or parallel lines, mark 'em. 8. Develop a plan of attack. You have your given. You've written down what you want. You've drawn your diagram. Now you have to develop a plan to solve the proof. A plan of attack can be everything from which auxiliary lines you need to draw to the type of reasoning you're going to use to solve the proof. A plan before you start gives you direction and saves on the number of steps you'll have to take to get from the given to the prove statements. 9. Read through the statements. This suggestion works best with completed proofs — proofs actually completed by someone else, like in a book about geometry. Read through the numbered information in the Statements column. Try to figure out what the reason should be for each statement. Check to see whether you're correct. If you are, go on to the next statement. If you aren't, figure out why the reason is what it is before you proceed. Going through the steps without having to create them and just trying to understand the logic behind them is the best way to get a handle on complex proofs. 10. Apply geometry objects to the real world. There are lots of things to remember in geometry. You can start expanding your mental capacity by knowing how to answer, "What is geometry, anyway?" Geometry is everywhere! Apply the objects of geometry to the real world as you learn about them. Make everything a mind game. For circles, think pizza. For rectangles, think tennis courts. For spheres, think baseballs. You get the idea. Associating the information to something you already understand not only helps speed up your understanding but also improves your chances of keeping the info in your memory. . 11. Play Pool! This final tip is here to give you a good example of how to apply geometry to the real world. Pool is all about angles. Hit the ball off one bumper at a certain angle, and it may hit another ball. Change the angle and you may hit the ball so that it rebounds from one bumper to another and sinks a solid colored ball. You may scratch or mistakenly sink the 8 ball. So play pool — angles, angles, angles! 1. Lines and angles 13. Transformations Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Historical development of geometry Part of the "Tab.Geometry." (Table of Geometry) from the 1728 Cyclopaedia GeometryProjecting a sphere to a plane Branches Euclidean Non-Euclidean Elliptic Spherical Hyperbolic Non-Archimedean geometry Projective Affine Synthetic Analytic Algebraic Arithmetic Diophantine Differential Riemannian Symplectic Discrete differential Complex Finite Discrete/Combinatorial Digital Convex Computational Fractal Incidence Noncommutative geometry Noncommutative algebraic geometry ConceptsFeaturesDimension Straightedge and compass constructions Angle Curve Diagonal Orthogonality (Perpendicular) Parallel Vertex Congruence Similarity Symmetry Zero-dimensional Point One-dimensional Line segment ray Length Two-dimensional Plane Area Polygon Triangle Altitude Hypotenuse Pythagorean theorem Parallelogram Square Rectangle Rhombus Rhomboid Quadrilateral Trapezoid Kite Circle Diameter Circumference Area Three-dimensional Volume Cube cuboid Cylinder Dodecahedron Icosahedron Octahedron Pyramid Platonic Solid Sphere Tetrahedron Four-/other-dimensional Tesseract Hypersphere Geometers by name Aida Aryabhata Ahmes Alhazen Apollonius Archimedes Atiyah Baudhayana Bolyai Brahmagupta Cartan Chern Coxeter Descartes Euclid Euler Gauss Gromov Hilbert Huygens Jyeṣṭhadeva Kātyāyana Khayyám Klein Lobachevsky Manava Minkowski Minggatu Pascal Pythagoras Parameshvara Poincaré Riemann Sakabe Sijzi al-Tusi Veblen Virasena Yang Hui al-Yasamin Zhang List of geometers by period BCE Ahmes Baudhayana Manava Pythagoras Euclid Archimedes Apollonius 1–1400s Zhang Kātyāyana Aryabhata Brahmagupta Virasena Alhazen Sijzi Khayyám al-Yasamin al-Tusi Yang Hui Parameshvara 1400s–1700s Jyeṣṭhadeva Descartes Pascal Huygens Minggatu Euler Sakabe Aida 1700s–1900s Gauss Lobachevsky Bolyai Riemann Klein Poincaré Hilbert Minkowski Cartan Veblen Coxeter Chern Present day Atiyah Gromov vte Geometry (from the Ancient Greek: γεωμετρία; geo- "earth", -metron "measurement") arose as the field of knowledge dealing with spatial relationships. Geometry was one of the two fields of pre-modern mathematics, the other being the study of numbers (arithmetic). Classic geometry was focused in compass and straightedge constructions. Geometry was revolutionized by Euclid, who introduced mathematical rigor and the axiomatic method still in use today. His book, The Elements is widely considered the most influential textbook of all time, and was known to all educated people in the West until the middle of the 20th century.[1] In modern times, geometric concepts have been generalized to a high level of abstraction and complexity, and have been subjected to the methods of calculus and abstract algebra, so that many modern branches of the field are barely recognizable as the descendants of early geometry. (See Areas of mathematics and Algebraic geometry.) The earliest recorded beginnings of geometry can be traced to early peoples, such as the ancient Indus Valley (see Harappan mathematics) and ancient Babylonia (see Babylonian mathematics) from around 3000 BC. Early geometry was a collection of empirically discovered principles concerning lengths, angles, areas, and volumes, which were developed to meet some practical need in surveying, construction, astronomy, and various crafts. Among these were some surprisingly sophisticated principles, and a modern mathematician might be hard put to derive some of them without the use of calculus and algebra. For example, both the Egyptians and the Babylonians were aware of versions of the Pythagorean theorem about 1500 years before Pythagoras and the Indian Sulba Sutras around 800 BC contained the first statements of the theorem; the Egyptians had a correct formula for the volume of a frustum of a square pyramid. Main article: Egyptian geometry The ancient Egyptians knew that they could approximate the area of a circle as follows:[2] Area of Circle ≈ [(Diameter) x 8/9]2. Problem 50 of the Ahmes papyrus uses these methods to calculate the area of a circle, according to a rule that the area is equal to the square of 8/9 of the circle's diameter. This assumes that π is 4×(8/9)2 (or 3.160493...), with an error of slightly over 0.63 percent. This value was slightly less accurate than the calculations of the Babylonians (25/8 = 3.125, within 0.53 percent), but was not otherwise surpassed until Archimedes' approximation of 211875/67441 = 3.14163, which had an error of just over 1 in 10,000. Ahmes knew of the modern 22/7 as an approximation for π, and used it to split a hekat, hekat x 22/x x 7/22 = hekat;[citation needed] however, Ahmes continued to use the traditional 256/81 value for π for computing his hekat volume found in a cylinder. Problem 48 involved using a square with side 9 units. This square was cut into a 3x3 grid. The diagonal of the corner squares were used to make an irregular octagon with an area of 63 units. This gave a second value for π of 3.111... The two problems together indicate a range of values for π between 3.11 and 3.16. Problem 14 in the Moscow Mathematical Papyrus gives the only ancient example finding the volume of a frustum of a pyramid, describing the correct formula: V = 1 3 h (a 2 + a b + b 2) {\displaystyle V={\frac {1}{3}}h(a^{2}+ab+b^{2})} where a and b are the base and top side lengths of the truncated pyramid and h is the height. Main article: Babylonian mathematics The Babylonians may have known the general rules for measuring areas and volumes. They measured the circumference of a circle as three times the diameter and the area as one-twelfth the square of the circumference, which would be correct if π is estimated as 3. The volume of a cylinder was taken as the product of the base and the height, however, the volume of the frustum of a cone or a square pyramid was incorrectly taken as the product of the height and half the sum of the bases. The Pythagorean theorem was also known to the Babylonians. Also, there was a recent discovery in which a tablet used π as 3 and 1/8. The Babylonians are also known for the Babylonian mile, which was a measure of distance equal to about seven miles today. This measurement for distances eventually was converted to a time-mile used for measuring the travel of the Sun, therefore, representing time.[3] There have been recent discoveries showing that ancient Babylonians may have discovered astronomical geometry nearly 1400 years before Europeans did.[4] Rigveda manuscript in Devanagari The Indian Vedic period had a tradition of geometry, mostly expressed in the construction of elaborate altars. Early Indian texts (1st millennium BC) on this topic include the Satapatha Brahmana and the Śulba Sūtras.[5][6][7] The

Śulba Sūtras has been described as "the earliest extant verbal expression of the Pythagorean Theorem in the world, although it had already been known to the Old Babylonians."[8] They make use of Pythagorean triples,[9][10] which are particular cases of Diophantine equations.[11] According to mathematician S. G. Dani, the Babylonian cuneiform tablet Plimpton 322 written c. 1850 BC[12] "contains fifteen Pythagorean triples with quite large entries, including (13500, 12709, 18541) which is a primitive triple,[13] indicating, in particular, that there was sophisticated understanding on the topic" in Mesopotamia in 1850 BC.[14] "Since these tablets predate the Sulbasutras period by several centuries, taking into account the contextual appearance of some of the triples, it is reasonable to expect that similar understanding would have been there in India."[14] Dani goes on to say:[15] As the main objective of the Sulvasutras was to describe the constructions of altars and the geometric principles involved in them, the subject of Pythagorean triples, even if it had been well understood may still not have featured in the Sulvasutras. The occurrence of the triples in the Sulvasutras is comparable to mathematics that one may encounter in an introductory book on architecture or another similar applied area, and would not correspond directly to the overall knowledge on the topic at that time. Since, unfortunately, no other contemporaneous sources have been found it may never be possible to settle this issue satisfactorily. See also: Greek mathematics Pythagorean theorem: a2 + b2 = c2 Thales (635–543 BC) of Miletus (now in southwestern Turkey), was the first to whom deduction in mathematics is attributed. There are five geometric propositions for which he wrote deductive proofs, though his proofs have not survived. Pythagoras (582–496 BC) of Ionia, and later, Italy, then colonized by Greeks, may have been a student of Thales, and traveled to Babylon and Egypt. The theorem that bears his name may not have been his discovery, but he was probably one of the first to give a deductive proof of it. He gathered a group of students around him to study mathematics, music, and philosophy, and together they discovered most of what high school students learn today in their geometry courses. In addition, they made the profound discovery of incommensurable lengths and irrational numbers. Plato (427–347 BC) was a philosopher, highly esteemed by the Greeks. There is a story that he had inscribed above the entrance to his famous school, "Let none ignorant of geometry enter here." However, the story is considered to be untrue.[16] Though he was not a mathematician himself, his views on mathematics had great influence. Mathematicians thus accepted his belief that geometry should use no tools but compass and straightedge – never measuring instruments such as a marked ruler or a protractor, because these were a workman's tools, not worthy of a scholar. This dictum led to a deep study of possible compass and straightedge constructions, and three classic construction problems: how to use these tools to trisect an angle, to construct a cube twice the volume of a given cube, and to construct a square equal in area to a given circle. The proofs of the impossibility of these constructions, finally achieved in the 19th century, led to important principles regarding the deep structure of the real number system. Aristotle (384–322 BC), Plato's greatest pupil, wrote a treatise on methods of reasoning used in deductive proofs (see Logic) which was not substantially improved upon until the 19th century. Statue of Euclid in the Oxford University Museum of Natural History Woman teaching geometry. Illustration at the beginning of a medieval translation of Euclid's Elements (c. 1310) Euclid (c. 325–265 BC), of Alexandria, probably a student at the Academy founded by Plato, wrote a treatise in 13 books (chapters), titled The Elements of Geometry, in which he presented geometry in an ideal axiomatic form, which came to be known as Euclidean geometry. The treatise is not a compendium of all that the Hellenistic mathematicians knew at the time about geometry; Euclid himself wrote eight more advanced books on geometry. We know from other references that Euclid's was not the first elementary geometry textbook, but it was so much superior that the others fell into disuse and were lost. He was brought to the university at Alexandria by Ptolemy I, King of Egypt. The Elements began with definitions of terms, fundamental geometric principles (called axioms or postulates), and general quantitative principles (called common notions) from which all the rest of geometry could be logically deduced. Following are his five axioms, somewhat paraphrased to make the English easier to read. Any two points can be joined by a straight line. Any finite straight line can be extended in a straight line. A circle can be drawn with any center and any radius. All right angles are equal to each other. If two straight lines in a plane are crossed by another straight line (called the transversal), and the interior angles between the two lines and the transversal lying on one side of the transversal add up to less than two right angles, then on that side of the transversal, the two lines extended will intersect (also called the parallel postulate). Concepts, that are now understood as algebra, were expressed geometrically by Euclid, a method referred to as Greek geometric algebra. Archimedes (287–212 BC), of Syracuse, Sicily, when it was a Greek city-state, was one of the most famous mathematicians of the Hellenistic period. He is known for his formulation of a hydrostatic principle (known as Archimedes' principle) and for his works on geometry, including Measurement of the Circle and On Conoids and Spheroids. His work On Floating Bodies is the first known work on hydrostatics, of which Archimedes is recognized as the founder. Renaissance translations of his works, including the ancient commentaries, were enormously influential in the work of some of the best mathematicians of the 17th century, notably René Descartes and Pierre de Fermat.[17] Geometry was connected to the divine for most medieval scholars. The compass in this 13th-century manuscript is a symbol of God's act of Creation. After Archimedes, Hellenistic mathematics began to decline. There were a few minor stars yet to come, but the golden age of geometry was over. Proclus (410–485), author of Commentary on the First Book of Euclid, was one of the last important players in Hellenistic geometry. He was a competent geometer, but more importantly, he was a superb commentator on the works that preceded him. Much of that work did not survive to modern times, and is known to us only through his commentary. The Roman Republic and Empire that succeeded and absorbed the Greek city-states produced excellent engineers, but no mathematicians of note. The great Library of Alexandria was later burned. There is a growing consensus among historians that the Library of Alexandria likely suffered from several destructive events, but that the destruction of Alexandria's pagan temples in the late 4th century was probably the most severe and final one. The evidence for that destruction is the most definitive and secure. Caesar's invasion may well have led to the loss of some 40,000–70,000 scrolls in a warehouse adjacent to the port (as Luciano Canfora argues, they were likely copies produced by the Library intended for export), but it is unlikely to have affected the Library or Museum, given that there is ample evidence that both existed later.[18] Civil wars, decreasing investments in maintenance and acquisition of new scrolls and generally declining interest in non-religious pursuits likely contributed to a reduction in the body of material available in the Library, especially in the 4th century. The Serapeum was certainly destroyed by Theophilus in 391, and the Museum and Library may have fallen victim to the same campaign. See also: Indian mathematics In the Bakhshali manuscript, there is a handful of geometric problems (including problems about volumes of irregular solids). The Bakhshali manuscript also "employs a decimal place value system with a dot for zero."[19] Aryabhata's Aryabhatiya (499) includes the computation of areas and volumes. Brahmagupta wrote his astronomical work Brāhma Sphuṭa Siddhānta in 628. Chapter 12, containing 66 Sanskrit verses, was divided into two sections: "basic operations" (including cube roots, fractions, ratio and proportion, and barter) and "practical mathematics" (including mixture, mathematical series, plane figures, stacking bricks, sawing of timber, and piling of grain).[20] In the latter section, he stated his famous theorem on the diagonals of a cyclic quadrilateral:[20] Brahmagupta's theorem: If a cyclic quadrilateral has diagonals that are perpendicular to each other, then the perpendicular line drawn from the point of intersection of the diagonals to any side of the quadrilateral always bisects the opposite side. Chapter 12 also included a formula for the area of a cyclic quadrilateral (a generalization of Heron's formula), as well as a complete description of rational triangles (i.e. triangles with rational sides and rational areas). Brahmagupta's formula: The area, A, of a cyclic quadrilateral with sides of lengths a, b, c, d, respectively, is given by A = (s − a) (s − b) (s − c) (s − d) {\displaystyle A={\sqrt {(s-a)(s-b)(s-c)(s-d)}}} where s, the semiperimeter, given by: s = a + b + c + d 2 . {\displaystyle s={\frac {a+b+c+d}{2}}.} Brahmagupta's Theorem on rational triangles: A triangle with rational sides a , b , c {\displaystyle a,b,c} and rational area is of the form: a = u 2 v + v ,   b = u 2 w + w ,   c = u 2 v + u 2 w − (v + w) {\displaystyle a={\frac {u^{2}}{v}}+v,\ \ b={\frac {u^{2}}{w}}+w,\ \ c={\frac {u^{2}}{v}}+{\frac {u^{2}}{w}}-(v+w)} for some rational numbers u , v , {\displaystyle u,v,} and w {\displaystyle w} .[21] Parameshvara Nambudiri was the first mathematician to give a formula for the radius of the circle circumscribing a cyclic quadrilateral.[22] The expression is sometimes attributed to Lhuilier [1782], 350 years later. With the sides of the cyclic quadrilateral being a, b, c, and d, the radius R of the circumscribed circle is: R = (a b + c d) (a c + b d) (a d + b c) (− a + b + c + d) (a − b + c + d) (a + b − c + d) (a + b + c − d) . {\displaystyle R={\sqrt {\frac {(ab+cd)(ac+bd)(ad+bc)}{(-a+b+c+d)(a-b+c+d)(a+b-c+d)(a+b+c-d)}}}.} See also: Chinese mathematics The Nine Chapters on the Mathematical Art, first compiled in 179 AD, with added commentary in the 3rd century by Liu Hui Haidao Suanjing, Liu Hui, 3rd century The first definitive work (or at least oldest existent) on geometry in China was the Mo Jing, the Mohist canon of the early philosopher Mozi (470–390 BC). It was compiled years after his death by his followers around the year 330 BC.[23] Although the Mo Jing is the oldest existent book on geometry in China, there is the possibility that even older written material existed. However, due to the infamous Burning of the Books in a political maneuver by the Qin dynasty ruler Qin Shihuang (r. 221–210 BC), multitudes of written literature created before his time were purged. In addition, the Mo Jing presents geometrical concepts in mathematics that are perhaps too advanced not to have had a previous geometrical base or mathematic background to work upon. The Mo Jing described various aspects of many fields associated with physical science, and provided a small wealth of information on mathematics as well. It provided an 'atomic' definition of the geometric point, stating that a line is separated into parts, and the part which has no remaining parts (i.e. cannot be divided into smaller parts) and thus forms the extreme end of a line is a point.[23] Much like Euclid's first and third definitions and Plato's 'beginning of a line', the Mo Jing stated that "a point may stand at the end (of a line) or at its beginning like a head-presentation in childbirth. (As to its invisibility) there is nothing similar to it."[24] Similar to the atomists of Democritus, the Mo Jing stated that a point is the smallest unit, and cannot be cut in half, since 'nothing' cannot be halved.[24] It stated that two lines of equal length will always finish at the same place,[24] while providing definitions for the comparison of lengths and for parallels,[25] along with principles of space and bounded space.[26] It also described the fact that planes without the quality of thickness cannot be piled up since they cannot mutually touch.[27] The book provided definitions for circumference, diameter, and radius, along with the definition of volume.[28] The Han dynasty (202 BC – 220 AD) period of China witnessed a new flourishing of mathematics. One of the oldest Chinese mathematical texts to present geometric progressions was the Suàn shù shū of 186 BC, during the Western Han era. The mathematician, inventor, and astronomer Zhang Heng (78–139 AD) used geometrical formulas to solve mathematical problems. Although rough estimates for pi (π) were given in the Zhou Li (compiled in the 2nd century BC),[29] it was Zhang Heng who was the first to make a concerted effort at creating a more accurate formula for pi. Zhang Heng approximated pi as 730/232 (or approx 3.1466), although he used another formula of pi in finding a spherical volume, using the square root of 10 (or approx 3.162) instead. Zu Chongzhi (429–500 AD) improved the accuracy of the approximation of pi to between 3.1415926 and 3.1415927, with 355⁄113 (密率, Milü, detailed approximation) and 22⁄7 (约率, Yuelü, rough approximation) being the other notable approximation.[30] In comparison to later works, the formula for pi given by the French mathematician Franciscus Vieta (1540–1603) fell halfway between Zu's approximations. The Nine Chapters on the Mathematical Art, the title of which first appeared by 179 AD on a bronze inscription, was edited and commented on by the 3rd century mathematician Liu Hui from the Kingdom of Cao Wei. This book included many problems where geometry was applied, such as finding surface areas for squares and circles, the volumes of solids in various three-dimensional shapes, and included the use of the Pythagorean theorem. The book provided illustrated proof for the Pythagorean theorem,[31] contained a written dialogue between of the earlier Duke of Zhou and Shang Gao on the properties of the right angle triangle and the Pythagorean theorem, while also referring to the astronomical gnomon, the circle and square, as well as measurements of heights and distances.[32] The editor Liu Hui listed pi as 3.141014 by using a 192 sided polygon, and then calculated pi as 3.14159 using a 3072 sided polygon. This was more accurate than Liu Hui's contemporary Wang Fan, a mathematician and astronomer from Eastern Wu, would render pi as 3.1555 by using 142⁄45.[33] Liu Hui also wrote of mathematical surveying to calculate distance measurements of depth, height, width, and surface area. In terms of solid geometry, he figured out that a wedge with rectangular base and both sides sloping could be broken down into a pyramid and a tetrahedral wedge.[34] He also figured out that a wedge with trapezoid base and both sides sloping could be made to give two tetrahedral wedges separated by a pyramid.[34] Furthermore, Liu Hui described Cavalieri's principle on volume, as well as Gaussian elimination. From the Nine Chapters, it listed the following geometrical formulas that were known by the time of the Former Han dynasty (202 BCE – 9 CE). Areas for the[35] Square Rectangle Circle Isosceles triangle Rhomboid Trapezoid Double trapezium Segment of a circle Annulus ('ring' between two concentric circles) Volumes for the[34] Parallelepiped with two square surfaces Parallelepiped with no square surfaces Pyramid Frustum of pyramid with square base Frustum of pyramid with rectangular base of unequal sides Cube Prism Wedge with rectangular base and both sides sloping Wedge with trapezoid base and both sides sloping Tetrahedral wedge Frustum of a wedge of the second type (used for applications in engineering) Cylinder Cone with circular base Frustum of a cone Sphere Continuing the geometrical legacy of ancient China, there were many later figures to come, including the famed astronomer and mathematician Shen Kuo (1031–1095 CE), Yang Hui (1238–1298) who discovered Pascal's Triangle, Xu Guangqi (1562–1633), and many others. See also: Islamic mathematics Page from the Al-Jabr wa-al-MuqabilahThābit ibn Qurra, using what he called the method of reduction and composition, provided two different general proofs of the Pythagorean theorem for all triangles, before which proofs only existed for the theorem for the special cases of a special right triangle.[36] A 2007 paper in the journal Science suggested that girih tiles possessed properties consistent with self-similar fractal quasicrystalline tilings such as the Penrose tilings.[37][38] An engraving by Albrecht Dürer featuring Mashallah, from the title page of the De scientia motus orbis (Latin version with engraving, 1504). As in many medieval illustrations, the compass here is an icon of religion as well as science, in reference to God as the architect of creation. The transmission of the Greek Classics to medieval Europe via the Arabic literature of the 9th to 10th century "Islamic Golden Age" began in the 10th century and culminated in the Latin translations of the 12th century. A copy of Ptolemy's Almagest was brought back to Sicily by Henry Aristippus (d. 1162), as a gift from the Emperor to King William I (r. 1154–1166). An anonymous student at Salerno travelled to Sicily and translated the Almagest as well as several works by Euclid from Greek to Latin.[39] Although the Sicilians generally translated directly from the Greek, when Greek texts were not available, they would translate from Arabic. Eugenius of Palermo (d. 1202) translated Ptolemy's Optics into Latin, drawing on his knowledge of all three languages in the task.[40] The rigorous deductive methods of geometry found in Euclid's Elements of Geometry were relearned, and further development of geometry in the styles of both Euclid (Euclidean geometry) and Khayyam (algebraic geometry) continued, resulting in an abundance of new theorems and concepts, many of them very profound and elegant. Advances in the treatment of perspective were made in Renaissance art of the 14th to 15th century which went beyond what had been achieved in antiquity. In Renaissance architecture of the Quattrocento, concepts of architectural order were explored and rules were formulated. A prime example of is the Basilica di San Lorenzo in Florence by Filippo Brunelleschi (1377–1446).[41] In c. 1413 Filippo Brunelleschi demonstrated the geometrical method of perspective, used today by artists, by painting the outlines of various Florentine buildings onto a mirror. Soon after, nearly every artist in Florence and in Italy used geometrical perspective in their paintings,[42] notably Masolino da Panicale and Donatello. Melozzo da Forlì first used the technique of upward foreshortening (in Rome, Loreto, Forlì and others), and was celebrated for that. Not only was perspective a way of showing depth, it was also a new method of composing a painting. Paintings began to show a single, unified scene, rather than a combination of several. As shown by the quick proliferation of accurate perspective paintings in Florence, Brunelleschi likely understood (with help from his friend the mathematician Toscanelli),[43] but did not publish, the mathematics behind perspective. Decades later, his friend Leon Battista Alberti wrote De pictura (1435/1436), a treatise on proper methods of showing distance in painting based on Euclidean geometry. Alberti was also trained in the science of optics through the school of Padua and under the influence of Biagio Pelacani da Parma who studied Alhazen's Optics. Piero della Francesca elaborated on Della Pittura in his De Prospectiva Pingendi in the 1470s. Alberti had limited himself to figures on the ground plane and giving an overall basis for perspective. Della Francesca fleshed it out, explicitly covering solids in any area of the picture plane. Della Francesca also started the now common practice of using illustrated figures to explain the mathematical concepts, making his treatise easier to understand than Alberti's. Della Francesca was also the first to accurately draw the Platonic solids as they would appear in perspective. Perspective remained, for a while, the domain of Florence. Jan van Eyck, among others, was unable to create a consistent structure for the converging lines in paintings, as in London's The Arnolfini Portrait, because he was unaware of the theoretical breakthrough just then occurring in Italy. However he achieved very subtle effects by manipulations of scale in his interiors. Gradually, and partly through the movement of academies of the arts, the Italian techniques became part of the training of artists across Europe, and later other parts of the world. The culmination of these Renaissance traditions finds its ultimate synthesis in the research of the architect, geometer, and optician Girard Desargues on perspective, optics and projective geometry. The Vitruvian Man by Leonardo da Vinci (c. 1490)[44] depicts a man in two superimposed positions with his arms and legs apart and inscribed in a circle and square. The drawing is based on the correlations of ideal human proportions with geometry described by the ancient Roman architect Vitruvius in Book III of his treatise De Architectura. Discourse on Method by René Descartes In the early 17th century, there were two important developments in geometry. The first and most important was the creation of analytic geometry, or geometry with coordinates and equations, by René Descartes (1596–1650) and Pierre de Fermat (1601–1665). This was a necessary precursor to the development of calculus and a precise quantitative science of physics. The second geometric development of this period was the systematic study of projective geometry by Girard Desargues (1591–1661). Projective geometry is the study of geometry without measurement, just the study of how points align with each other. There had been some early work in this area by Hellenistic geometers, notably Pappus (c. 340). The greatest flowering of the field occurred with Jean-Victor Poncelet (1788–1867). In the late 17th century, calculus was developed independently and almost simultaneously by Isaac Newton (1642–1727) and Gottfried Wilhelm Leibniz (1646–1716). This was the beginning of a new field of mathematics now called analysis. Though not itself a branch of geometry, it is applicable to geometry, and it solved two families of problems that had long been almost intractable: finding tangent lines to odd curves, and finding areas enclosed by those curves. The methods of calculus reduced these problems mostly to straightforward matters of computation. The very old problem of proving Euclid's Fifth Postulate, the "Parallel Postulate", from his first four postulates had never been forgotten. Beginning not long after Euclid, many attempted demonstrations were given, but all were later found to be faulty, through allowing into the reasoning some principle which itself had not been proved from the first four postulates. Though Omar Khayyám was also unsuccessful in proving the parallel postulate, his criticisms of Euclid's theories of parallels and his proof of properties of figures in non-Euclidean geometries contributed to the eventual development of non-Euclidean geometry. By 1700 a great deal had been discovered about what can be proved from the first four, and what the pitfalls were in attempting to prove the fifth. Saccheri, Lambert, and Legendre each did excellent work on the problem in the 18th century, but still fell short of success. In the early 19th century, Gauss, Johann Bolyai, and Lobachevsky, each independently, took a different approach. Beginning to suspect that it was impossible to prove the Parallel Postulate, they set out to develop a self-consistent geometry in which that postulate was false. In this they were successful, thus creating the first non-Euclidean geometry. By 1854, Bernhard Riemann, a student of Gauss, had applied methods of calculus in a ground-breaking study of the intrinsic (self-contained) geometry of all smooth surfaces, and thereby found a different non-Euclidean geometry. This work of Riemann later became fundamental for Einstein's theory of relativity. William Blake's "Newton" is a demonstration of his opposition to the 'single-vision' of scientific materialism; here, Isaac Newton is shown as 'divine geometer' (1795). It remained to be proved mathematically that the non-Euclidean geometry was just as self-consistent as Euclidean geometry, and this was first accomplished by Beltrami in 1868. With this, non-Euclidean geometry was established on an equal mathematical footing with Euclidean geometry. While it was now known that different geometric theories were mathematically possible, the question remained, "Which one of these theories is correct for our physical space?" The mathematical work revealed that this question must be answered by physical experimentation, not mathematical reasoning, and uncovered the reason why the experimentation must involve immense (interstellar, not earth-bound) distances. With the development of relativity theory in physics, this question became vastly more complicated. All the work related to the Parallel Postulate revealed that it was quite difficult for a geometer to separate his logical reasoning from his intuitive understanding of physical space, and, moreover, revealed the critical importance of doing so. Careful examination had uncovered some logical inadequacies in Euclid's reasoning, and some unstated geometric principles to which Euclid sometimes appealed. This critique paralleled the crisis occurring in calculus and analysis regarding the meaning of infinite processes such as convergence and continuity. In geometry, there was a clear need for a new set of axioms, which would be complete, and which in no way relied on pictures we draw or on our intuition of space. Such axioms, now known as Hilbert's axioms, were given by David Hilbert in 1894 in his dissertation Grundlagen der Geometrie (Foundations of Geometry). In the mid-18th century, it became apparent that certain progressions of mathematical reasoning recurred when similar ideas were studied on the number line, in two dimensions, and in three dimensions. Thus the general concept of a metric space was created so that the reasoning could be done in more generality, and then applied to special cases. This method of studying calculus- and analysis-related concepts came to be known as analysis situs, and later as topology. The important topics in this field were properties of more general figures, such as connectedness and boundaries, rather than properties like straightness, and precise equality of length and angle measurements, which had been the focus of Euclidean and non-Euclidean geometry. Topology soon became a separate field of major importance, rather than a sub-field of geometry or analysis. See also: Euclidean geometry § 19th century The 19th century saw the development of the general concept of Euclidean space by Ludwig Schläfli, who extended Euclidean geometry beyond three dimensions. He discovered all the higher-dimensional analogues of the Platonic solids, finding that there are exactly six such regular convex polytopes in dimension four, and three in all higher dimensions. In 1878 William Kingdon Clifford introduced what is now termed geometric algebra, unifying William Rowan Hamilton's quaternions with Hermann Grassmann's algebra and revealing the geometric nature of these systems, especially in four dimensions. The operations of geometric algebra have the effect of mirroring, rotating, translating, and mapping the geometric objects that are being modeled to new positions. Developments in algebraic geometry included the study of curves and surfaces over finite fields as demonstrated by the works of among others André Weil, Alexander Grothendieck, and Jean-Pierre Serre as well as over the real or complex numbers. Finite geometry itself, the study of spaces with only finitely many points, found applications in coding theory and cryptography. With the advent of the computer, new disciplines such as computational geometry or digital geometry deal with geometric algorithms, discrete representations of geometric data, and so forth. Main article: Timeline of geometry Wikisource has original text related to this article: Flatland Flatland, a book by "A. Square" about two– and three-dimensional space, to understand the concept of four dimensions Timeline of geometry – Notable events in the history of geometry History of Euclidean geometry History of non-Euclidean geometry History of mathematics History of measurement History of space (mathematics) Important publications in geometry Interactive geometry software List of geometry topics Modern triangle geometry ^ Howard Eves, An Introduction to the History of Mathematics, Saunders: 1990 (ISBN 0-03-029558-0), p. 141: "No work, except The Bible, has been more widely used...." ^ Ray C. Jurgensen, Alfred J. Donnelly, and Mary P. Dolciani. Editorial Advisors Andrew M. Gleason, Albert E. Meder, Jr. Modern School Mathematics: Geometry (Student's Edition). Houghton Mifflin Company, Boston, 1972, p. 52. ISBN 0-395-13102-2. Teachers Edition ISBN 0-395-13103-0. ^ Eves, Chapter 2. ^ "Clay tablets reveal Babylonians discovered astronomical geometry 1,400 years before Europeans - The Washington Post". The Washington Post. ^ A. Seidenberg, 1978. The origin of mathematics. Archive for the history of Exact Sciences, vol 18. ^ (Staal 1999) ^ Most mathematical problems considered in the Śulba Sūtras spring from "a single theological requirement," that of constructing fire altars which have different shapes but occupy the same area. The altars were required to be constructed of five layers of burnt brick, with the further condition that each layer consist of 200 bricks and that no two adjacent layers have congruent arrangements of bricks. (Hayashi 2003, p. 118) ^ Hayashi 2005, p. 363. ^ Knudsen 2018, p. 87. ^ Pythagorean triples are triples of integers (a , b , c) {\displaystyle (a,b,c)} with the property: a 2 + b 2 = c 2 {\displaystyle a^{2}+b^{2}=c^{2}} . Thus, 3 2 + 4 2 = 5 2 {\displaystyle 3^{2}+4^{2}=5^{2}} , 8 2 + 15 2 = 17 2 {\displaystyle 8^{2}+15^{2}=17^{2}} , 12 2 + 35 2 = 37 2 {\displaystyle 12^{2}+35^{2}=37^{2}} etc. ^ (Cooke 2005, p. 198): "The arithmetic content of the Śulva Sūtras consists of rules for finding Pythagorean triples such as (3, 4, 5), (5, 12, 13), (8, 15, 17), and (12, 35, 37). It is not certain what practical use these arithmetic rules had. The best conjecture is that they were part of religious ritual. A Hindu home was required to have three fires burning at three different altars. The three altars were to be of different shapes, but all three were to have the same area. These conditions led to certain "Diophantine" problems, a particular case of which is the generation of Pythagorean triples, so as to make one square integer equal to the sum of two others." ^ Mathematics Department, University of British Columbia, The Babylonian tabled Plimpton 322. ^ Three positive integers (a , b , c) {\displaystyle (a,b,c)} form a primitive Pythagorean triple if c 2 = a 2 + b 2 {\displaystyle c^{2}=a^{2}+b^{2}} and if the highest common factor of a , b , c {\displaystyle a,b,c} is 1. In the particular Plimpton322 example, this means that 13500 2 + 12709 2 = 18541 2 {\displaystyle 13500^{2}+12709^{2}=18541^{2}} and that the three numbers do not have any common factors. However some scholars have disputed the Pythagorean interpretation of this tablet; see Plimpton 322 for details. ^ a b Dani 2003, p. 223. ^ Dani 2003, p. 223–224. ^ Cherowitzo, Bill. "What precisely was written over the door of Plato's Academy?" (PDF). www.math.ucdenver.edu/. 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(London: Zwemmer, 1993). ^ "...and these works (of perspective by Brunelleschi) were the means of arousing the minds of the other craftsmen, who afterwards devoted themselves to this with great zeal."Vasari's Lives of the Artists Chapter on Brunelleschi ^ "Messer Paolo dal Pozzo Toscanelli, having returned from his studies, invited Filippo with other friends to supper in a garden, and the discourse falling on mathematical subjects, Filippo formed a friendship with him and learned geometry from him."Vasarai's Lives of the Artists, Chapter on Brunelleschi ^ The Secret Language of the Renaissance - Richard Stemp Cooke, Roger (2005), The History of Mathematics, New York: Wiley-Interscience, 632 pages, ISBN 978-0-471-44459-6 Dani, S. G. 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