CAMBRIDGE
International Examinations

Cambridge
IGCSE

SYLLABUS

Cambridge IGCSE®
Additional Mathematics (US)

0459

For examination in June and November 2019.

Please check the syllabus page at **www.cie.org.uk/igcse** to see if this syllabus is available in your administrative zone.

Cambridge Secondary 2

Version 1

Note

Administration materials appear in UK English and are standard for all our international customers. Please read the *Cambridge Glossary* alongside this syllabus. This is available from our website.

Contents

1. Introduction

1.1 Why Choose Cambridge?

Cambridge International Examinations prepares school students for life, helping them develop an informed curiosity and a lasting passion for learning. We are part of Cambridge Assessment, a department of the University of Cambridge.

Our international qualifications are recognized by the world's best universities and employers, giving students a wide range of options in their education and career. As a nonprofit organization, we devote our resources to delivering high-quality educational programs that can unlock student's potential.

Our programs and qualifications set the global standard for international education. They are created by subject experts, rooted in academic rigor and reflect the latest educational research. They provide a strong platform for students to progress from one stage to the next, and are well supported by teaching and learning resources.

Every year, nearly a million Cambridge students from 10,000 schools in 160 countries prepare for their future with an international education from Cambridge.

Cambridge Students

Our mission is to provide educational benefit through provision of international programs and qualifications for school education and to be the world leader in this field. Together with schools, we develop Cambridge students who are:

- **confident** in working with information and ideas – their own and those of others
- **responsible** for themselves, responsive to and respectful of others
- **reflective** as students, developing their ability to learn
- **innovative** and equipped for new and future challenges
- **engaged** intellectually and socially, ready to make a difference.

Recognition

Cambridge IGCSE is recognized by leading universities and employers worldwide, and is an international passport to progression and success. It provides a solid foundation for moving on to higher level studies. Learn more at **www.cie.org.uk/recognition**

Support for Teachers

A wide range of materials and resources is available to support teachers and students in Cambridge schools. Resources suit a variety of teaching methods in different international contexts. Through subject discussion forums and training, teachers can access the expert advice they need for teaching our qualifications. More details can be found in Section 2 of this syllabus and at **www.cie.org.uk/teachers**

Support for Exams Officers

Exams officers can trust in reliable, efficient administration of exams entries and excellent personal support from our customer services. Learn more at **www.cie.org.uk/examsofficers**

Our systems for managing the provision of international qualifications and education programs for students aged 5 to 19 are certified as meeting the internationally recognized standard for quality management, ISO 9001:2008. Learn more at **www.cie.org.uk/ISO9001**

1.2 Why Choose Cambridge IGCSE?

Cambridge IGCSEs are international in outlook, but retain a local relevance. The syllabi provide opportunities for contextualized learning and the content has been created to suit a wide variety of schools, avoid cultural bias and develop essential lifelong skills, including creative thinking and problem-solving.

Our goal is to balance knowledge, understanding, and skills in our programs and qualifications to enable students to become effective learners and to provide a solid foundation for their continuing educational journey.

Through our professional development courses and our support materials for Cambridge IGCSEs, we provide the tools to enable teachers to prepare students to the best of their ability and work with us in the pursuit of excellence in education.

Cambridge IGCSEs are considered to be an excellent preparation for Cambridge International AS & A Levels, the Cambridge AICE (Advanced International Certificate of Education) Diploma, Cambridge Pre-U, and other education programs, such as the US Advanced Placement program and the International Baccalaureate Diploma program. Learn more about Cambridge IGCSEs at **www.cie.org.uk/cambridgesecondary2**

Guided Learning Hours

Cambridge IGCSE syllabi are designed on the assumption that candidates have about 130 guided learning hours per subject over the duration of the course, but this is for guidance only. The number of hours required to gain the qualification may vary according to local curricular practice and the candidates' prior experience of the subject.

1.3 Why Choose Cambridge IGCSE Additional Mathematics?

Cambridge IGCSE Additional Mathematics is accepted by universities and employers as proof of essential mathematical knowledge and ability.

The Additional Mathematics syllabus builds on the skills and knowledge developed in the Cambridge IGCSE Mathematics (US) (0444) syllabus.

Successful Cambridge IGCSE Additional Mathematics candidates gain lifelong skills, including:

- the further development of mathematical concepts and principles
- the extension of mathematical skills and their use in more advanced techniques
- an ability to solve problems, present solutions logically, and interpret results
- a solid foundation for further study.

Prerequisites

We recommend that candidates who are beginning this course should have previously studied Cambridge IGCSE Mathematics (US) (0444).

Progression

Cambridge IGCSEs are general qualifications that enable candidates to progress directly to employment, or to proceed to further qualifications in another subject area or at a higher level, requiring more specific knowledge, understanding and skills.

Candidates who are awarded grades A* to C in Cambridge IGCSE Additional Mathematics (US) are well prepared to follow courses leading to Cambridge International AS & A Level Mathematics, or the equivalent.

1.4 Cambridge ICE (International Certificate of Education)

Cambridge ICE is a group award for Cambridge IGCSE. It gives schools the opportunity to benefit from offering a broad and balanced curriculum by recognizing the achievements of candidates who pass examinations in a number of different subjects.

Learn more about Cambridge ICE at **www.cie.org.uk/cambridgesecondary2**

1.5 How Can I Find Out More?

If You Are Already a Cambridge school

You can make entries for this qualification through your usual channels. If you have any questions, please contact us at **info@cie.org.uk**

If You Are Not Yet a Cambridge school

Learn about the benefits of becoming a Cambridge school at **www.cie.org.uk/startcambridge**. Email us at **info@cie.org.uk** to find out how your organization can register to become a Cambridge school.

2. Teacher Support

2.1 Support Materials

You can go to our public website at **www.cie.org.uk/igcse** to download current and future syllabi together with specimen papers or past question papers, examiner reports and grade threshold tables from one series.

For teachers at registered Cambridge schools a range of additional support materials for specific syllabi is available from Teacher Support, our secure online support for Cambridge teachers. Go to **https://teachers.cie.org.uk** (username and password required). If you do not have access, speak to the Teacher Support coordinator at your school.

2.2 Endorsed Resources

We work with publishers providing a range of resources for our syllabi including print and digital materials. Resources endorsed by Cambridge go through a detailed quality assurance process to make sure they provide a high level of support for teachers and students.

We have resource lists which can be filtered to show all resources, or just those which are endorsed by Cambridge. The resource lists include further suggestions for resources to support teaching. See **www.cie.org.uk/i-want-to/resource-centre** for further information.

2.3 Training

We offer a range of support activities for teachers to ensure they have the relevant knowledge and skills to deliver our qualifications. See **www.cie.org.uk/events** for further information.

3. Assessment at a Glance

This qualification is assessed via two components: Paper 1 and Paper 2.

Component	Weighting	Raw score	Nature of assessment
1 Written paper **2 hours** 9–14 questions of various lengths. No choice of question.	50%	80	External
2 Written paper **2 hours** 9–14 questions of various lengths. No choice of question.	50%	80	External

Grades A* to E will be available for candidates who achieve the required standards. Since there is no Core Curriculum for this syllabus, Grades F and G will not be available. Therefore, candidates who do not achieve the minimum mark for Grade E will be unclassified.

Calculators

The syllabus assumes that candidates will be in possession of an electronic calculator with scientific functions for both papers. Algebraic or graphic calculators are **not** permitted.

Non-exact numerical answers will be required to be given correct to three significant figures, or one decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

List of Formulas

The mathematical formulas and tables provided in the List of Formulas and Statistical Tables (MF25) is given in the appendix.

Availability

This syllabus is examined in the June and November examination series.

All Cambridge schools are allocated to one of six administrative zones. Each zone has a specific timetable. This syllabus is **not** available in all administrative zones. To find out about the availability visit the syllabus page at **www.cie.org.uk/igcse**

Detailed timetables are available from **www.cie.org.uk/timetables**

Combining This with Other Syllabi

Candidates can combine this syllabus in an examination series with any other Cambridge syllabus, except:

- syllabi with the same title at the same level
- 4037 Cambridge O Level Additional Mathematics
- 0606 Cambridge IGCSE Additional Mathematics

Please note that Cambridge IGCSE, Cambridge IGCSE (9–1) (Level 1/Level 2 Certificate) and Cambridge O Level syllabi are at the same level.

4. Syllabus Goals and Objectives

4.1 Goals

The goals of the syllabus listed below are not in order of priority.

The goals are to enable candidates to:

- consolidate and extend their elementary mathematical skills, and use these in the context of more advanced techniques
- further develop their knowledge of mathematical concepts and principles, and use this knowledge for problem solving
- appreciate the interconnectedness of mathematical knowledge
- acquire a suitable foundation in mathematics for further study in the subject or in mathematics-related subjects
- devise mathematical arguments and use and present them precisely and logically
- integrate information technology (IT) to enhance the mathematical experience
- develop the confidence to apply their mathematical skills and knowledge in appropriate situations
- develop creativity and perseverance in the approach to problem solving
- derive enjoyment and satisfaction from engaging in mathematical pursuits, and gain an appreciation of the beauty, power, and usefulness of mathematics.

4.2 Assessment Objectives

The examination will test the ability of candidates to:

- recall and use manipulative techniques
- interpret and use mathematical data, symbols, and terminology
- comprehend numerical, algebraic, and spatial concepts and relationships
- recognize the appropriate mathematical procedure for a given situation
- formulate problems into mathematical terms and select and apply appropriate techniques of solution.

Any of the above objectives can be assessed in any question in Components 1 and 2.

5. Curriculum Content

Candidates are expected to have followed the Extended Curriculum of the Cambridge IGCSE Mathematics (US) (0444).

Grades A* to E are available.

Proofs of standard results will not be required unless specifically mentioned below.

Candidates will be expected to be familiar with the scientific notation for the expression of compound units, e.g., 5 m s^{-1} for 5 meters per second.

1	Number	Notes/Exemplars
Complex Numbers		
1.1	Understand the idea of a complex number, recall the meaning of the terms real part, imaginary part, modulus, argument, conjugate, and use the fact that two complex numbers are equal if and only if both real and imaginary parts are equal.	Know there is a complex number i such that $i^2 = -1$, and every complex number has the form a + ib with a and b real.
1.2	Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, multiply, and divide two complex numbers expressed in the form x + iy.	
1.3	Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.	
1.4	Represent complex numbers geometrically in the complex plane in rectangular and polar form, and convert between the rectangular and polar forms of a complex number.	
1.5	Understand in simple terms the geometrical effects of conjugating a complex number and of adding, subtracting, and multiplying two complex numbers, and use properties of this representation.	e.g., $(-1 + \sqrt{3}i)^3 = 8$ because $(-1 + \sqrt{3}i)$ has modulus 2 and argument 120°
1.6	Calculate the distance between numbers represented in the complex plane and the midpoint of a line segment.	
1.7	Solve quadratic equations with real coefficients that have complex solutions.	
1.8	Extend polynomial identities to the complex numbers.	e.g., rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$

Indices and Radicals		
1.9	Perform simple operations with indices and with surds, including rationalizing the denominator.	
Matrices		
1.10	Display information in the form of a matrix of any order and interpret the data in a given matrix.	
1.11	Solve problems involving the calculation of the sum and product (where appropriate) of two matrices and interpret the results.	Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.
1.12	Calculate the product of a scalar quantity and a matrix.	
1.13	Use the algebra of 2 × 2 matrices (including the zero and identity matrix).	
1.14	Calculate the determinant and inverse of a non-singular 2 × 2 matrix and solve simultaneous linear equations.	The determinant of a square matrix is non-zero if, and only if, the matrix has a multiplicative inverse.
1.15	Work with 2 × 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.	
2	**Algebra**	**Notes/Exemplars**
Factors, Polynomials, and Rational Expressions		
2.1	Know and use the remainder and factor theorems to find factors of polynomials and solve cubic equations.	
2.2	Identify zeros of polynomials when suitable factorizations are available, use the zeros to construct a rough graph of the function defined by the polynomial, and know the Fundamental Theorem of Algebra.	
2.3	Express simple rational expressions in different forms including writing $\frac{a(x)}{b(x)}$ in the form $q(x) + \frac{r(x)}{b(x)}$, where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), by using inspection or long division and prove polynomial identities.	

2.4	Add, subtract, multiply, and divide polynomial and rational expressions.	Understand that polynomials and rational expressions form a system analogous to the integers, namely, they are closed under the operation of addition, subtraction, and multiplication; add, subtract, and multiply polynomials and rational expressions.
Simultaneous Equations		
2.5	Solve simultaneous equations in two unknowns with at least one linear equation.	e.g., find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$
3	**Functions**	**Notes/Exemplars**
Functions		
3.1	Understand the terms: function, domain, range (image set), one-one function, inverse function and composition of functions.	
3.2	Use the notation $f(x) = \sin x$, $f: x \mapsto \lg x$, $(x > 0)$, $f^{-1}(x)$ and $f^2(x)$ [$= f(f(x))$].	
3.3	Understand the relationship between $y = f(x)$ and $y = \lvert f(x) \rvert$, where $f(x)$ may be linear, quadratic, or trigonometric.	
3.4	Explain in words why a given function is a function or why it does not have an inverse and produce an invertible function from a non-invertible function by restricting the domain.	e.g., understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed
3.5	Find the inverse of a one-one function and form composite functions, including verifying by composition that one function is the inverse of another.	
3.6	Use sketch graphs to show the relationship between a function and its inverse.	
3.7	Graph functions and show key features of the graph, including understanding points of intersection.	To include linear, quadratic, square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

3.8	Recognize even and odd functions from their graphs and algebraic expressions.	
3.9	Construct a function that describes a relationship between two quantities, including determining an explicit expression or a recursive relation, together with constant multiples, sums, and composites of functions.	e.g., • construct a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model • if T(h) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time
3.10	Recognize that sequences are functions, which may be defined recursively and whose domain is a subset of the integers.	e.g., the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n + 1) = f(n) + f(n – 1) for n 1
Logarithmic and Exponential Functions		
3.11	Understand and know simple properties and graphs of the logarithmic and exponential functions including ln x and e^x (series expansions are not required) including interpreting the parameters in a linear or exponential function in terms of a context.	
3.12	Know and use the laws of logarithms (including change of base of logarithms).	Simplify expressions and solve simple equations involving logarithms.
3.13	Solve equations of the form $a^x = b$, including use of logarithms to base 2, 10, or e.	e.g., • solve $5^x = 7$ • solve $2e^{3t} = 12$
3.14	Distinguish between situations that can be modeled with linear functions and with exponential functions.	
4	**Geometry**	**Notes/Exemplars**
4.1	Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if, and only if, corresponding pairs of sides and corresponding pairs of angles are congruent.	
4.2	Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motion.	

4.3	Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.	Candidates will be expected to know and use the following theorems in their proofs: Lines and angles: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints. Triangles: measure of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segments joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point; a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity. Parallelograms: opposite sides are congruent; opposite angles are congruent; the diagonals of a parallelogram bisect each other and conversely, rectangles are parallelograms with congruent diagonals.
5	**Transformations and Vectors**	**Notes/Exemplars**
5.1	Use vectors in any form, e.g. $\begin{pmatrix} x \\ y \end{pmatrix}$, $\overrightarrow{AB}$, $\mathbf{a}$, $x\mathbf{i} + y\mathbf{j}$.	
5.2	Know and use position vectors and unit vectors.	
5.3	Find the magnitude and direction of a vector, add and subtract vectors and multiply vectors by scalars; determine the magnitude and direction of the sum of two vectors.	
5.4	Compose and resolve velocities.	
5.5	Solve problems involving velocity and other quantities that can be represented by vectors and use relative velocity, including solving problems on interception (but not closest approach).	

6	Coordinate Geometry	Notes/Exemplars
Coordinate Geometry		
6.1	Interpret the equation of a straight line graph in the form y = mx + c.	
6.2	Use slope criteria for parallel and perpendicular lines to solve geometric problems with justification.	
6.3	Solve questions involving midpoint and length of a line.	e.g., to find the equation of a circle given the endpoints of the diameter
6.4	Use coordinates to prove simple geometric properties algebraically.	e.g., • determine whether a figure defined by four given points in the coordinate plane is a rectangle • determine whether the point (1, √3) lies on the circle which is centered at the origin and passes through the point (0, 2)
6.5	Derive the equation of a circle given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.	
6.6	Derive the equation of a parabola given a focus and directrix.	
6.7	Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.	
7	**Trigonometry**	**Notes/Exemplars**
7.1	Solve problems involving the arc length and sector area of a circle, including knowledge and use of radian measure.	Derive, using similarity, the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.
7.2	Know and use the three trigonometric functions of angles of any magnitude (sine, cosine, tangent).	
7.3	Determine geometrically the values of sine, cosine, tangent for $\frac{\pi}{3}$ and $\frac{\pi}{4}$, and $\frac{\pi}{6}$ express the values of sine, cosine, and tangent for $\pi - x$, $\pi + x$, and $2\pi - x$ in terms of their values for x, where x is any real number.	
7.4	Understand the symmetry (odd and even) and periodicity of trigonometric functions.	

7.5	Understand amplitude and periodicity and the relationship between graphs of, e.g., sin x and sin 2x.	
7.6	Draw and use the graphs of $y = a \sin bx + c$ $y = a \cos bx + c$ $y = a \tan bx + c$ where a and b are positive integers and c is an integer.	
7.7	Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.	
7.8	Prove and use the relationships $\frac{\sin\theta}{\cos\theta} = \tan\theta$ $\sin^2\theta + \cos^2\theta = 1$ and solve simple trigonometric equations involving the three trigonometric functions and the above relationships (not including general solution of trigonometric equations).	Includes the use of inverse trigonometric functions. May use inverse functions to solve trigonometric equations that arise in modeling contexts.
7.9	Prove and use the expansions of sin (A ± B), cos (A ± B), and tan (A ± B) to solve simple trigonometric problems.	
7.10	Prove simple trigonometric identities.	
8	**Probability**	**Notes/Exemplars**
8.1	Understand and use the conditional probability of A given B as $\frac{P(A \text{ and } B)}{P(B)}$ or as the fraction of B's outcomes that also belong to A; interpret independence of A and B in relation to conditional probabilities and the product of probabilities.	e.g., compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer
8.2	Apply P(A and B) = P(A)P(B|A) = P(B)P(A|B) in simple situations, and interpret the answer in context.	
8.3	Use permutations and combinations to compute probabilities of compound events and solve problems.	
8.4	Define a random variable X by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions; and calculate E(X) and Var(X).	

8.5	Investigate the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. Find the expected payoff for a game of chance. Evaluate and compare strategies on the basis of expected values.	e.g., • find the expected winnings from a state lottery ticket • compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident
8.6	Analyze decisions and strategies using probability concepts.	e.g., product testing, medical testing, pulling a hockey goalie at the end of a game
9	**Statistics**	**Notes/Exemplars**
9.1	Understand the concept of sampling and recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.	
9.2	Use data from a sample survey to estimate a population mean or proportion; use data to compare two variables.	
9.3	Interpret differences in shape, center, and spread in the context of data sets, accounting for possible effects of outliers.	
9.4	Use standardized values and normal tables for normally distributed continuous data in determining probabilities as areas under the normal curve.	
9.5	Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate.	
9.6	Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.	
9.7	Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities.	

9.8	Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. • Fit a function to the data; use functions (e.g., linear, quadratic, exponential) fitted to data to solve problems in the context of the data • Informally assess the fit of a function by plotting and analyzing residuals • Fit a linear function for a scatter plot that suggests a linear association • Fit a function to the data; use functions fitted to data to solve problems in the context of the data • Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data	
9.9	Interpret the correlation coefficient of a linear fit and distinguish between correlation and causation.	

7. Other Information

Equality and Inclusion

Cambridge International Examinations has taken great care in the preparation of this syllabus and assessment materials to avoid bias of any kind. To comply with the UK Equality Act (2010), Cambridge has designed this qualification with the goal of avoiding direct and indirect discrimination.

The standard assessment arrangements may present unnecessary barriers for candidates with disabilities or learning difficulties. Arrangements can be put in place for these candidates to enable them to access the assessments and receive recognition of their attainment. Access arrangements will not be agreed if they give candidates an unfair advantage over others or if they compromise the standards being assessed.

Candidates who are unable to access the assessment of any component may be eligible to receive an award based on the parts of the assessment they have taken.

Information on access arrangements is found in the Cambridge Handbook which can be downloaded from the website **www.cie.org.uk/examsofficers**

Language

This syllabus and the associated assessment materials are available in English only.

Grading and Reporting

Cambridge IGCSE results are shown by one of the grades A*, A, B, C, D, E, F or G indicating the standard achieved, A* being the highest and G the lowest. "Ungraded" indicates that the candidate's performance fell short of the standard required for grade G. "Ungraded" will be reported on the statement of results but not on the certificate. The letters Q (result pending), X (no result) and Y (to be issued) may also appear on the statement of results but not on the certificate.

Entry Option Codes

To maintain the security of our examinations, we produce question papers for different areas of the world, known as "administrative zones". Where the component entry option code has two digits, the first digit is the component number given in the syllabus. The second digit is the location code, specific to an administrative zone. Information about entry option codes can be found in the Cambridge Guide to Making Entries.

8. Appendix

8.1 List of Formulas and Statistical Tables for Components 1 and 2

ALGEBRA

Quadratic Equation

For the equation $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$

$$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$$

$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

Formulas for ΔABC

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

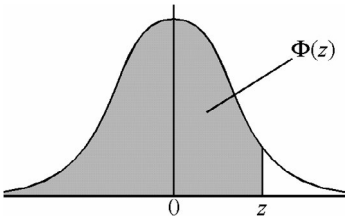
$$\Delta = \frac{1}{2} ab \sin C$$

THE NORMAL DISTRIBUTION FUNCTION

If Z has a normal distribution with mean 0 and variance 1 then, for each value of z, the table gives the value of $\Phi(z)$, where

$$\Phi(z) = \mathrm{P}(Z \leq z).$$

For negative values of z use $\Phi(-z) = 1 - \Phi(z)$.



z	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
											ADD								
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359	4	8	12	16	20	24	28	32	36
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753	4	8	12	16	20	24	28	32	36
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141	4	8	12	15	19	23	27	31	35
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517	4	7	11	15	19	22	26	30	34
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879	4	7	11	14	18	22	25	29	32
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224	3	7	10	14	17	20	24	27	31
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549	3	7	10	13	16	19	23	26	29
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852	3	6	9	12	15	18	21	24	27
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133	3	5	8	11	14	16	19	22	25
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389	3	5	8	10	13	15	18	20	23
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621	2	5	7	9	12	14	16	19	21
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830	2	4	6	8	10	12	14	16	18
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015	2	4	6	7	9	11	13	15	17
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177	2	3	5	6	8	10	11	13	14
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319	1	3	4	6	7	8	10	11	13
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441	1	2	4	5	6	7	8	10	11
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545	1	2	3	4	5	6	7	8	9
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633	1	2	3	4	4	5	6	7	8
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706	1	1	2	3	4	4	5	6	6
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767	1	1	2	2	3	4	4	5	5
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817	0	1	1	2	2	3	3	4	4
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857	0	1	1	2	2	2	3	3	4
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890	0	1	1	1	2	2	2	3	3
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916	0	1	1	1	1	2	2	2	2
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936	0	0	1	1	1	1	1	2	2
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952	0	0	0	1	1	1	1	1	1
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964	0	0	0	0	1	1	1	1	1
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974	0	0	0	0	0	1	1	1	1
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981	0	0	0	0	0	0	0	1	1
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986	0	0	0	0	0	0	0	0	0

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