Maryland Mathematics

Precalculus

Precalculus A	Precalculus A

Number and Quantity N

CN. THE COMPLEX NUMBER SYSTEM N.CN

C Use complex numbers in polynomial identities and equations. N.CN.C

8 Extend polynomial identities to the complex numbers. For example, rewrite + 2 x 4 as ( ) ( ) x ix i +– 22 . N.CN.C.8

1 Apply the Complex Conjugate Theorem when:

1 solving polynomial equations with degrees greater than or equal to two.

2 analyzing the graph of a polynomial.

3 building a polynomial given one complex root.

. Clarifications/Examples:

. Function families to which this standard applies:

1 Polynomial Functions

2 Rational Functions

9 Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials. N.CN.C.9

. Clarifications/Examples:

1 Apply knowledge of Fundamental Theorem of Algebra to solving polynomial equations of degree 3 and higher.

2 Students should be able to identify existence of complex roots.

3 Make connections between the nature of the roots of an equation and the behavior of the graph of the function.

. Function families to which this standard applies:

1 Polynomial Functions

2 Rational Functions

Algebra A

SSE. SEEING STRUCTURE IN EXPRESSIONS A.SSE

Skip to main content

A Interpret the structure of expressions. A.SSE.A

2 Use the structure of an expression to identify ways to rewrite it. A.SSE.A.2

Clarifications/Examples:

1 Use factors of polynomials to simplify/analyze rational expressions and the graphs of the related functions.

2 Factor polynomial expressions, of degree three and higher, completely, over the complex number system (e.g. Factor $xx4 - 3xx2 - 28$ to $(xx2 + 4)(xx2 - 7)$ and then to .

3 Rewrite trigonometric expressions based on algebraic structures .

4 Discuss conjugates and how their structure can help when simplifying expressions, verifying identities and solving equations.

5 Factor expressions to include using the sum and difference of cubes (e.g. Factor $xx6 - 27yy3$).

6 Recognize and factor an expression in quadratic form (e.g. $ee2xx - 9eexx + 14$, $2\cos 2\,xx - 3\cos xx + 1$, $xx6 - 9xx3 + 8$).

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

2 Polynomial Functions

3 Radical Power Functions

4 Rational Functions

5 Trigonometric Functions

Skip to main content

B Write expressions in equivalent forms to solve problems. A.SSE.B

3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. A.SSE.B.3

Clarifications/Examples:

1 Produce an equivalent form of a rational expression to reveal information about the behavior of the graph of the related function.

number and type of discontinuities

zeros

asymptotes and holes

2 Rewrite complex fractions as rational expressions .

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

2 Polynomial Functions

3 Radical Power Functions

4 Rational Functions

5 Trigonometric Functions

3.c Use the properties of exponents to transform expressions for exponential functions. For example, the expression 11.1111^{tt} can be rewritten as to reveal the approximate equivalent monthly interest rate if the annual rate is 15%. A.SSE.B.3.C

Clarifications/Examples:

1 Model in context.

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

APR. ARITHMETIC WITH POLYNOMIALS AND RATIONAL EXPRESSIONS A.APR

Skip to main content

B Understand the relationship between zeroes and factors of polynomials. A.APR.B

2 Know and apply the Remainder Theorem: For a polynomial $pp(xx)$ and a number a, the remainder on division by $xx - aa$ is $pp(aa)$, so $pp(aa) = 00$ if and only if $(xx - aa)$ is a factor of $pp(xx)$. A.APR.B.2

Clarifications/Examples:

1 Factor polynomials to simplify rational expressions.

2 Use the Remainder Theorem to determine zeros (roots) of a polynomial.

Function families to which this standard applies:

1 Polynomial Functions

2 Rational Functions

3.a Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. A.APR.B.3.A

Clarifications/Examples:

1 Identify real zeros of polynomials.

2 Understand the relationship between the degree of a polynomial and the number and nature of the zeros of the polynomial.

Function families to which this standard applies:

1 Polynomial Functions

C Use polynomial identities to solve problems. A.APR.C

5 Know and apply the Binomial Theorem for the expansion of $(xx + yy)nn$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle. A.APR.C.5

Clarifications/Examples:

1 Limit to $nn \leq 5$, and binomials with variables coefficient of one, or constants less than four.

Function families to which this standard applies:

1 Polynomial Functions

Skip to main content

D Rewrite rational expressions. A.APR.D

6 Rewrite simple rational expressions in different forms. A.APR.D.6

Clarifications/Examples:

1 Rational expressions have no restrictions on degree of the numerator or denominator.

2 Understand the connection between rewriting rational expressions and using long division when factoring polynomials.

Apply the Rational Root Theorem.

Function families to which this standard applies:

1 Polynomial Functions

2 Rational Functions

7 Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication and division by a nonzero rational expression; add, subtract, multiply and divide rational expressions. A.APR.D.7

Clarifications/Examples:

1 Emphasize operations on rational expressions.

Function families to which this standard applies:

1 Rational Functions

CED. CREATING EQUATIONS A.CED

Skip to main content

A Create equations that describe numbers or relationships. A.CED.A

1.a Create equations and inequalities in one variable and use them to solve problems. A.CED.A.1.A

Clarifications/Examples:

1 Create equations and inequalities in one variable involving all algebraic and transcendental functions and piecewise defined functions that combine different types of functions.

2 Use equations and inequalities that arise from any type of function to solve problems.

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

2 Polynomial Functions

3 Radical Power Functions

4 Rational Functions

5 Trigonometric Functions

1b Create polynomial equations given roots. A.CED.A.1B

Clarifications/Examples:

1 Use the Factor Theorem.

2 Use the Conjugate Root Theorem as it applies to irrationals.

Function families to which this standard applies:

1 Polynomial Functions

3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. A.CED.A.3

Clarifications/Examples:

1 Understand why constraints exist for certain equations and inequalities and for systems of equations and inequalities.

2 Represent constraints of equations that contain composite expressions .

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

2 Polynomial Functions

3 Radical Power Functions

4 Rational Functions

5 Trigonometric Functions

REI. REASONING WITH EQUATIONS AND INEQUALITIES A.REI

Skip to main content

B Solve equations and inequalities on one variable. A.REI.B

B Solve equations and inequalities in one variable. A.REI.B

Clarifications/Examples:

1. Include equations and inequalities that contain combinations of various algebraic and transcendental functions.
2. Include equations that contain composite expressions.
3. Solve equations in one variable algebraically, numerically and/or graphically.
4. Justify solution methods.

Function families to which this standard applies:

1. Logarithmic/Exponential Functions
2. Polynomial Functions
3. Radical Power Functions
4. Rational Functions
5. Trigonometric Functions

C Solve systems of equations. A.REI.C

7a Solve systems of equations comprised of various combinations of all algebraic and transcendental functions in two variables. A.REI.C.7A

Clarifications/Examples:

1. Explore algebraic, numeric and graphical methods for solving systems of equations.
2. Explore systems comprised of functions from two different function families (e.g. Solve the system $yy = xx2$ and $yy = 2 \cos xx$).

Function families to which this standard applies:

1. Logarithmic/Exponential Functions
2. Polynomial Functions
3. Radical Power Functions
4. Rational Functions
5. Trigonometric Functions

Functions F

IF. INTERPRETING FUNCTIONS F.IF

Skip to main content

A Understand the concept of a function and use function notation. F.IF.A

2a Extend evaluating functions to include operations with composite functions, e.g. $ff(xx + 2) - ff(xx)$. F.IF.A.2A

Clarifications/Examples:

1 Build prerequisite skills needed to simplify difference quotient (e.g. Given $ff(xx) = xx2 + 3xx + 1$ find $ff(xx + h)$).

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

2 Polynomial Functions

3 Radical Power Functions

4 Rational Functions

5 Trigonometric Functions

Skip to main content

B Interpret functions that arise in application in terms of context. F.IF.B

4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities; sketch graphs showing key features given a verbal description of the relationship. F.IF.B.4

Clarifications/Examples:

1 Interpret the key features of the graph of any function in terms of context.
2 Explore rate of change over various size intervals.
3 Estimate points of inflection.
4 Describe the concavity on intervals.
5 Explain how to recognize asymptotic behavior given various representations of a function (algebraic, numeric and graphic).

Function families to which this standard applies:

1 Logarithmic/Exponential Functions
2 Polynomial Functions
3 Radical Power Functions
4 Rational Functions
5 Trigonometric Functions

5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. F.IF.B.5

Clarifications/Examples:

1 Discuss the domain of all function types including composite and inverse functions.

Function families to which this standard applies:

1 Logarithmic/Exponential Functions
2 Polynomial Functions
3 Radical Power Functions
4 Rational Functions
5 Trigonometric Functions

Skip to main content

C Analyze functions using different representations. F.IF.C

7f Graph all functions including piecewise-defined functions, step functions and absolute value functions F.IF.C.7F

Clarifications/Examples:

1. Sketch polynomials of higher degree from factored form, using x- and y-intercepts, end behavior and degree.
2. Describe end behavior using appropriate notation, i.e. given an equation, as $xx \to \pm\infty, ff(xx) \to \pm\infty$.
3. Use information about end behavior of a polynomial to sketch and identify the possible degree of a polynomial.
4. Graph inverse trigonometric functions and identify the related principal values.

Function families to which this standard applies:

1. Logarithmic/Exponential Functions
2. Polynomial Functions
3. Radical Power Functions
4. Rational Functions
5. Trigonometric Functions

7g Determine the end behavior of the graph of a polynomial function using the degree and leading coefficient. F.IF.C.7G

Clarifications/Examples:

1. Refer to the wording of the standard.

Function families to which this standard applies:

1. Polynomial Functions

8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. F.IF.C.8

Clarifications/Examples:

1. Understand why a particular form of an expression would reveal properties such as zeros, extrema, intercepts, etc.
2. Rewrite rational functions to reveal discontinuities.

Function families to which this standard applies:

1. Logarithmic/Exponential Functions
2. Polynomial Functions
3. Radical Power Functions
4. Rational Functions
5. Trigonometric Functions

Skip to main content

9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables or by a verbal description). F.IF.C.9

Clarifications/Examples:

1 Extend student understanding by using more complex situations.

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

2 Polynomial Functions

3 Radical Power Functions

4 Rational Functions

5 Trigonometric Functions

BF. BUILDING FUNCTIONS F.BF

Skip to main content

A Build a function that models a relationship between two quantities. F.BF.A

1 Write a function that describes a relationship between two quantities, including more complex functions. F.BF.A.1

Clarifications/Examples:

1 Include piecewise defined functions comprised of different types of functions.

2 Include composite functions (e.g. $ff(xx) = \sin(2xx)$).

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

2 Polynomial Functions

3 Radical Power Functions

4 Rational Functions

5 Trigonometric Functions

1c Compose functions. For example, if $TT(yy)$ is the temperature in the atmosphere as a function of height, and $h(tt)$ is the height of a weather balloon as a function of time, then is the temperature at the location of the weather balloon as a function of time. F.BF.A.1C

Clarifications/Examples:

1 Identify the domain and range of a composite function.

2 Recognize when a function is the composition of two simpler functions (e.g. $ff(xx) = ee\sin xx$).

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

2 Polynomial Functions

3 Radical Power Functions

4 Rational Functions

5 Trigonometric Functions

Skip to main content

B Build new functions from existing functions. F.BF.B

3 Identify the effect on the graph of replacing $ff(xx)$ by $ff(xx) + kk$, $kkkk(xx)$, $ff(kkkk)$, and $ff(xx + kk)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. F.BF.B.3

Clarifications/Examples:

1 Identify any function as an even, an odd function or neither given a graphic or algebraic representation.

2 Identify transformations from parent functions.

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

2 Polynomial Functions

3 Trigonometric Functions

4 Radical Power Functions

5 Rational Functions

4 Find inverse functions. F.BF.B.4

Clarifications/Examples:

1 Find inverses of polynomials of the form $ff(xx) = aa(xx - h)nn + kk$.

2 Note: Read the blog, Inverse Functions: We're Teaching it all Wrong, before teaching inverses.

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

2 Polynomial Functions

3 Radical Power Functions

4 Rational Functions

5 Trigonometric Functions

4b Verify by composition that one function is the inverse of another. F.BF.B.4B

Clarifications/Examples:

1 Refer to the wording of the standard.

Function families to which this standard applies:

1 Polynomial Functions

2 Radical Power Functions

3 Rational Functions

Skip to main content

4c Read values of an inverse function from a graph or a table, given that the function has an inverse. F.BF.B.4C

Clarifications/Examples:

1. Given the numeric or graphic representation of an invertible function, produce the graphic and numeric representation of the inverse.
2. Interpret the reflection of a function over the line $yy = xx$ as a representation of the inverse of a function.

Function families to which this standard applies:

1. Logarithmic/Exponential Functions
2. Polynomial Functions
3. Radical Power Functions
4. Rational Functions
5. Trigonometric Functions

4d Produce an invertible function from a non-invertible function by restricting the domain. F.BF.B.4D

Clarifications/Examples:

1. Refer to the wording of the standard.

Function families to which this standard applies:

1. Polynomial Functions
2. Radical Power Functions
3. Trigonometric Functions

4e Build inverse trigonometric functions. F.BF.B.4E

Clarifications/Examples:

1. Build from unit circle.

Function families to which this standard applies:

1. Trigonometric Functions

5 Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents. F.BF.B.5

Clarifications/Examples:

1. Solve exponential equations using logarithms.
2. Discuss relationships between domain, range, and asymptotes.

Function families to which this standard applies:

1. Logarithmic/Exponential Functions

LE. LINEAR, QUADRATIC, AND EXPONENTIAL MODELS F.LE

Skip to main content

A Construct and compare linear, quadratic, and exponential models and solve problems. F.LE.A

4a Use properties of logarithms, including both common and natural logarithms, to rewrite and solve exponential models. F.LE.A.4A

Clarifications/Examples:

1 Write logarithmic functions as inverses of exponential functions, including both common and natural logarithms.

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

TF. TRIGONOMETRIC FUNCTIONS F.TF

A Extend the domain of trigonometric functions using the unit circle. F.TF.A

2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle. F.TF.A.2

Clarifications/Examples:

1 Define the six trigonometric functions in terms of coordinates from the unit circle.

2 Understand the relationship between right triangle trigonometric ratios and trigonometric functions.

3 Evaluate trigonometric functions using reference angles.

Function families to which this standard applies:

1 Trigonometric Functions

3 Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi\pi$ 3 , $\pi\pi$ 4 , $aaaaaa\ \pi\pi$ 6 and use the unit circle to express the values of sine, cosine F.TF.A.3

Clarifications/Examples:

1 Refer to the wording of the standard.

Function families to which this standard applies:

1 Trigonometric Functions

4 Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions. F.TF.A.4

Clarifications/Examples:

1 Write the domain of all six trigonometric functions.

2 Write the domain of trigonometric functions under transformations (e.g. yy = tan xx versus yy = tan(2xx)).

Function families to which this standard applies:

Skip to main content

1 Trigonometric Functions

B Model periodic phenomena with trigonometric functions. F.TF.B

5 Choose trigonometric functions to model real world phenomena. F.TF.B.5

Clarifications/Examples:

1 Graph all six trigonometric functions.

Function families to which this standard applies:

1 Trigonometric Functions

6 Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed. F.TF.B.6

Clarifications/Examples:

1 Refer to the wording of the standard.

Function families to which this standard applies:

1 Trigonometric Functions

7 Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology and interpret them in context. F.TF.B.7

Clarifications/Examples:

1 Refer to the wording of the standard.

Function families to which this standard applies:

1 Trigonometric Functions

C Prove and apply trigonometric identities. F.TF.C

9.a Use trigonometric identities to rewrite expressions and as a tool when solving trigonometric equations. F.TF.C.9.A

Clarifications/Examples:

1 Use the double angle and half angle identities for trigonometric functions to simplify, verify, and solve expressions and equations involving sine, cosine, and tangent.

2 Emphasize double angle identities are used most frequently in Calculus.

3 Prove trigonometric identities, including Pythagorean identities and even and odd identities, using a variety of strategies. Verify identities graphically.

4 Emphasize Pythagorean identities.

Function families to which this standard applies:

1 Trigonometric Functions

Geometry G **SRT. SIMILARITY, RIGHT TRIANGLES, AND TRIGONOMETRY** G.SRT

Skip to main content

D Apply trigonometry to general triangles. G.SRT.D

10 Prove the Laws of Sines and Cosines and use them to solve problems. G.SRT.D.10

Clarifications/Examples:

1 Refer to the wording of the standard.

Function families to which this standard applies:

1 Trigonometric Functions

11 Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying, resultant forces). G.SRT.D.11

Clarifications/Examples:

1 Refer to the wording of the standard.

Function families to which this standard applies:

1 Trigonometric Functions

Statistics S

ID. INTERPRETING CATEGORICAL AND QUANTITATIVE DATA S.ID

B Summarize, represent, and interpret data on two categorical and quantitative variables. S.ID.B

6d Fit a function to data represented by a scatterplot; use functions fitted to data to solve problems in the context of the data. S.ID.B.6D

Clarifications/Examples:

1 Determine the best function to represent data on two-quantitative variables by analyzing the context of the data; the behavior of the scatterplot and the fit of the function to the scatterplot.

Function families to which this standard applies:

1 Logarithmic/Exponential Functions

2 Polynomial Functions

3 Radical Power Functions

4 Trigonometric Functions

Logistics Growth **Logistics Growth**

Functions F

LE. INEAR, QUADRATIC, AND EXPONENTIAL MODELS F.LE

Skip to main content

A Construct and compare linear, quadratic, and exponential models and solve problems. F.LE.A

1.d Distinguish between situations that can be modeled with exponential functions and logistic functions. F.LE.A.1.D

Clarifications/Examples:

1 Refer to the wording of the standard.

B Interpret expressions for functions in terms of the situation they model. F.LE.B

5a Interpret the parameters in a logistic function in terms of a context. F.LE.B.5A

Clarifications/Examples:

1 Interpret the parameters A, B, and C in expressions of the form $yy = CC$ $1+AAee-BBBB$, in terms of a context.

6 Build and interpret logistic functions to model real-world problems. F.LE.B.6

Clarifications/Examples:

1 Refer to the wording of the standard.

6a Sketch and analyze the graphs of logistic functions. F.LE.B.6A

Clarifications/Examples:

1 Refer to the wording of the standard.

6b Compare and contrast the exponential, logarithmic, and logistic models. F.LE.B.6B

Clarifications/Examples:

1 Refer to the wording of the standard.

6c Apply understanding of logarithmic and logistic functions to solve real-world problems. F.LE.B.6C

Clarifications/Examples:

1 Refer to the wording of the standard.

Precalculus B **Precalculus B**

Number and Quantity N **CN. THE COMPLEX NUMBER SYSTEM** N.CN

A Perform arithmetic operations with complex numbers. N.CN.A

3 Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers. N.CN.A.3

Clarifications/Examples:

1 Understand the connection between modulus of a complex number and the magnitude of a vector.

Skip to main content

B Represent Complex Numbers and their operations on the complex plane. N.CN.B

4 Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number. N.CN.B.4

Clarifications/Examples:

1 Refer to the wording of the standard.

5 Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. N.CN.B.5

Clarifications/Examples:

1 Refer to the wording of the standard.

6 Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints. N.CN.B.6

Clarifications/Examples:

1 This could be addressed in a unit on vectors or polar coordinates.

Vectors and Matrices **Vectors and Matrices**

Number and Quantity N **VM. VECTOR AND MATRIX QUANTITIES** N.VM

A Represent and model with vector quantities. N.VM.A

1 Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes ($\mathbf{ee}$. $\mathbf{gg}$. $\mathbf{vv}$, $|\mathbf{vv}|$, $\|\mathbf{vv}\|$, $\boldsymbol{vv}$) N.VM.A.1

Clarifications/Examples:

1 Understand vocabulary and notation associated with the study of vectors (magnitude, direction, scalar, components, unit vector, resultant force).

2 Write position vectors from initial and terminal points.

2 Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. N.VM.A.2

Clarifications/Examples:

1 Analyze vectors in terms of their horizontal and vertical components.

3 Solve problems involving velocity and other quantities that can be represented by vectors. N.VM.A.3

Clarifications/Examples:

1 Model situations involving multiple vectors.

2 Determine resultant vectors and interpret them in context.

Skip to main content

B Perform operations on vectors. N.VM.B

4 Add and subtract vectors. N.VM.B.4

Clarifications/Examples:

1 Refer to the wording of the standard.

4.a Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. N.VM.B.4.A

Clarifications/Examples:

1 Add vectors symbolically and graphically.

4.b Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. N.VM.B.4.B

Clarifications/Examples:

1 Use right triangles to derive formulas for the direction and magnitude of a vector.

2 Determine whether a system is in equilibrium.

4.c Understand vector subtraction $\mathbf{vv} - \mathbf{ww}$ as $\mathbf{vv} + (-\mathbf{ww})$, where $-\mathbf{ww}$ is the additive inverse of $\mathbf{ww}$, with the same magnitude as $\mathbf{ww}$ and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise. N.VM.B.4.C

Clarifications/Examples:

1 Refer to the wording of the standard.

5 Multiply a vector by a scalar. N.VM.B.5

Clarifications/Examples:

1 Refer to the wording of the standard.

5.a Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c v v cv cv ( ) ( ) xy x y ,, = . N.VM.B.5.A

Clarifications/Examples:

1 Refer to the wording of the standard.

5.b Compute the magnitude of a scalar multiple $cc\mathbf{vv}$ using $\|cc\mathbf{vv}\| = |cc|\mathbf{vv}$. Compute the direction of $cc\mathbf{vv}$ knowing that when $|cc|\mathbf{vv} \neq 0$, the direction of $cc\mathbf{vv}$ is either along $\mathbf{vv}$ (for $cc > 0$) or against $\mathbf{vv}$ (for $cc > 0$). N.VM.B.5.B

Clarifications/Examples:

1 Refer to the wording of the standard.

5.c Determine the dot product of two vectors. N.VM.B.5.C

Clarifications/Examples:

1 Refer to the wording of the standard.

Skip to main content

C Perform operations on matrices and use matrices in applications. N.VM.C

6 Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network. N.VM.C.6

Clarifications/Examples:

1 Refer to the wording of the standard.

7 Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled. N.VM.C.7

Clarifications/Examples:

1 Refer to the wording of the standard.

8 Add, subtract, and multiply matrices of appropriate dimensions. N.VM.C.8

Clarifications/Examples:

1 Refer to the wording of the standard.

9 Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties. N.VM.C.9

Clarifications/Examples:

1 Refer to the wording of the standard.

10 Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse. N.VM.C.10

Clarifications/Examples:

1 Refer to the wording of the standard.

11 Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors. N.VM.C.11

Clarifications/Examples:

1 Refer to the wording of the standard.

12 Work with 2 × 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area. N.VM.C.12

Clarifications/Examples:

1 Include rotations of 90°, 180°, and 270°, and reflections across x-axis, y-axis, and over the line $yy = xx$.

A Write and interpret numerical expressions. N.OA.A

1 Use the notation for the factorial of a non-negative integer, n!, to evaluate expressions. N.OA.A.1

Clarifications/Examples:

1 Refer to the wording of the standard.

Algebra A

SSE. SEEING STRUCTURE IN EXPRESSIONS A.SSE

B Write expressions in equivalent forms to solve problems. A.SSE.B

4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. A.SSE.B.4

Clarifications/Examples:

1 Connect prior learning from Algebra 2 to the new learning in Precalculus.

2 Solve real world problems that involve finite series.

4.a Express the sums in a series using sigma notation. A.SSE.B.4.A

Clarifications/Examples:

1 Use the algebra rules for finite sums to evaluate expressions written using sigma notation

2 Find the partial sums of a series defined using sigma notation.

5 Determine the sum, if it exists, of an infinite geometric series. A.SSE.B.5

Clarifications/Examples:

1 Use the sum of an infinite geometric series to express a repeating decimal as a rational number.

2 Solve real world problems that involve infinite series.

3 Use the algebra rules for finite sums to evaluate expressions written using sigma notation .

APR. ARITHMETIC WITH POLYNOMIALS AND RATIONAL EXPRESSION A.APR

C Use polynomial identities to solve problems. A.APR.C

5 Know and apply the Binomial Theorem for the expansion of $(xx + yy)nn$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle. A.APR.C.5

Clarifications/Examples:

1 Limit to $nn < 6$.

2 Limit to binomials with variable coefficient of one or constants less than four.

3 Understand the connection between the Binomial Theorem and an infinite series.

Skip to main content

Functions F

IF. INTERPRETING FUNCTIONS F.IF

A Understand the concept of function and use function notation. F.IF.A

3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. F.IF.A.3

Clarifications/Examples:

1 Understand the similarities and differences between linear functions and arithmetic sequences.

2 Understand similarities and differences between exponential functions and geometric sequences.

3 Include sequences that do not have a simple defining equation.

C Analyze functions using different representations. F.IF.C

10 Describe the behavior of a sequence. F.IF.C.10

Clarifications/Examples:

1 Generate the terms of a sequence given a formula for the nth term of the sequence.

2 Use the graph of a sequence to intuitively determine if the sequence converges or diverges.

3 Determine if a sequence is increasing, decreasing, or monotonic.

BF. BUILDING FUNCTIONS F.BF

C Build a function that models a relationship between two quantities. F.BF.C

1 Write a function that describes a relationship between two quantities. F.BF.C.1

Clarifications/Examples:

1 Understand the connection between the formula for the general term $aann$ of a given sequence and the related function that describes the relationship between the term number of the sequence and the value of the term.

2 Graph and analyze the functions that represent a given sequence.

1.a Determine an explicit expression, a recursive process, or steps for calculation from a context. F.BF.C.1.A

Clarifications/Examples:

1 Include a variety of sequences that are neither arithmetic nor geometric.

2 Write sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. F.BF.C.2

Clarifications/Examples:

1 Construct a formula for the general term $aann$ of a given sequence.

Functions F

IF. INTERPRETING FUNCTIONS F.IF

A Understand the concept of function and use function notation. F.IF.A

2a Understand the concept of limit of a function. F.IF.A.2A

Clarifications/Examples:

1 Understand that the value of a function at a given point may not be the same as the limit as the function approaches the given point.

2 Understand when limits fail to exist.

C Analyze functions using different representations. F.IF.C

8c Interpret the behavior of the graph of a function using the concept of limits. F.IF.C.8C

Clarifications/Examples:

1 Use limits to reveal asymptotic or unbounded behavior.

2 Use limits to analyze functions for intervals of continuity or points of discontinuity.

3 Identify different types of discontinuities.

8d Estimate limits algebraically, numerically and graphically. F.IF.C.8D

Clarifications/Examples:

1 Use various algebraic techniques for evaluating limits.

2 Use a table of values to estimate a limit.

3 Use graphs to estimate limits.

4 Find one-sided limits.

5 Understand and use properties of limits.

Topics in Analytic Geometry

Topics in Analytic Geometry

Algebra

SSE. SEEING STRUCTURE IN EXPRESSIONS A.SSE

Skip to main content

A Interpret the structure of expressions. A.SSE.A

2.a Analyze the structure of the general form of a second degree equation, $AAxx22 + BBBBBB + CCyy22 + DDDD + EEEE + FF = 00$, to identify the conic section represented by the equation. A.SSE.A.2.A

Clarifications/Examples:

1 Evaluate the discriminant, $BB2 - 4AAAA$, of the general form of a second degree equation, $AAxx2 + BBBBBB + CCyy2 + DDDD + EEEE + FF = 0$, to determine if the graph of the equation is a circle, an ellipse, a hyperbola or a parabola.

3.d Choose and produce an equivalent form of a second degree equation, $AAxx2 + CCyy2 + DDDD + EEEE + FF = 0$, to reveal and explain properties of the conic section represented by the equation. A.SSE.B.3.D

Clarifications/Examples:

1 Produce the standard form of a second degree equation given the general form.

2 Recognize how the coefficients of the terms transform the conic section.

3.e Translate between the standard and general form, $AAxx2 + CCyy2 + DDDD + EEEE + FF = 0$, of a second degree equation. A.SSE.B.3.E

Clarifications/Examples:

1 Identify key features of a conic section.

2 Recognize how the coefficients of the terms transform the conic section.

Geometry G

GMD. GEOMETRIC MEASUREMENT AND DIMENSION G.GMD

B Visualize relationships between two-dimensional and three-dimensional objects. G.GMD.B

4a Identify the shapes of two-dimensional cross-sections of a right double cone. G.GMD.B.4A

Clarifications/Examples:

1 Include special cases of plane/cone intersections that result in degenerate conic sections.

GPE. EXPRESSING GEOMETRIC PROPERTIES WITH EQUATIONS G.GPE

Skip to main content

A Translate between the geometric description and the equation for a conic section. G.GPE.A

1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation. G.GPE.A.1

Clarifications/Examples:

1 Understand and apply the locus definition for the circle.

2 Connect the geometric definition of the circle to its algebraic equation.

3 Understand the concept of eccentricity of conic sections, and understand the eccentricity of the circle.

4 Use eccentricity to write equations of circles.

2 Derive the equation of a parabola given a focus and directrix. G.GPE.A.2

Clarifications/Examples:

1 Include parabolas that have a horizontal axis of symmetry and parabolas that have a vertical axis of symmetry.

2 Derive the standard form of a parabola, centered at the origin.

3 Understand and apply the locus definition for the parabola.

4 Connect the geometric definition of the parabola to its algebraic equation.

5 Understand the concept of eccentricity of conic sections, and understand the eccentricity of the parabola.

6 Use eccentricity to write equations of parabolas.

3 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. G.GPE.A.3

Clarifications/Examples:

1 Derive the standard form of an ellipse and a hyperbola, centered at the origin.

2 Understand and apply the locus definitions of the ellipse and the hyperbola.

3 Connect the geometric definitions of the ellipse and hyperbola to their algebraic equations.

4 Understand the concept of eccentricity of conic sections, and understand the eccentricity of the ellipse and the hyperbola.

5 Use eccentricity to write equations of ellipses and hyperbolas.

A Analyze parametric equations. P.IPE.A

1 Sketch the curve defined by parametric equations. P.IPE.A.1

Clarifications/Examples:

1 Indicate with an arrow on the curve the direction in which the curve is traced as t increases.

2 Describe the motion of a particle with position ( ) xy , as t varies in a given interval.

2 Use parametric equations to model and solve motion problems. P.IPE.A.2

Clarifications/Examples:

1 Refer to the wording of the standard.

CED. CREATING EQUATIONS P.CED

A Creating equations that describe numbers or relationships. P.CED.A

1 Create a single equation, using rectangular coordinates, that is equivalent to a pair of parametric equations. P.CED.A.1

Clarifications/Examples:

1 Refer to the wording of the standard.

2 Given a data set, create a parametric equation and a single equation using rectangular coordinates to fit the data. P.CED.A.2

Clarifications/Examples:

1 Refer to the wording of the standard.

Polar Coordinate System and Polar Equations — **Polar Coordinate System and Polar Equations**

Geometry G — **GPE. EXPRESSING GEOMETRIC PROPERTIES WITH EQUATIONS** G.GPE

Skip to main content

C Polar Coordinates. G.GPE.C

8 Understand the relationship between polar coordinates and Cartesian coordinates. G.GPE.C.8

Clarifications/Examples:

1 Understand that a single point on the polar coordinate plane has more than one set of polar coordinates that can be used to identify the location of the point.

9 Convert between polar and rectangular coordinates. G.GPE.C.9

Clarifications/Examples:

1 Refer to the wording of the standard.

10 Plot points on a polar coordinate grid. G.GPE.C.10

Clarifications/Examples:

1 Refer to the wording of the standard.

D Polar Equations. G.GPE.D

11 Convert equations between polar and rectangular forms. G.GPE.D.11

Clarifications/Examples:

1 Refer to the wording of the standard.

12 Graph polar equations by hand and using technology. G.GPE.D.12

Clarifications/Examples:

1 Make connections between the structure of a polar equation and the shape of the corresponding graph.

2 Graphs could include circles, lines, rose curves, cardioids, lemniscates, limaçons and spirals.

13 Solve systems of polar equations. G.GPE.D.13

Clarifications/Examples:

1 Restrict solutions to $[0, 2\pi)$.