

ARKANSAS
MATHEMATICS STANDARDS

DRAFT

Algebra II & III
Technical Math
Quantitative Reasoning
Advance Topics & Modeling
Statistics
Pre-Calculus & Calculus
Critical Algebra I

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ALGEBRA II MATH STANDARDS

Radicals and Complex Numbers

Radical Expressions and Rational Exponents

Students apply properties to radical expressions and rational exponents.

- A2.RC.1:** Explain how extending the properties of integer exponents to rational exponents provides an alternative notation for radicals.
- A2.RC.2:** Apply the properties of exponents to translate between radical and exponential forms of expressions.
- A2.RC.3:** Simplify and perform operations with radical expressions with and without variables; rationalizing denominators should include conjugates.

Complex Numbers

Students apply properties to complex numbers.

- A2.RC.4:** Know there is a complex number i and describe a context from which complex numbers appear.
- A2.RC.5:** Perform the operations of addition, subtraction, multiplication, and conjugation of complex numbers.
- A2.RC.6:** Use polynomial identities with complex numbers.

Functions

Compositions

Students compose and compare functions.

- A2.FN.1:** Combine functions by addition, subtraction, multiplication, division, and composition to model the relationship between two quantities in mathematical and real-world contexts.

Transformations

Students perform transformations in the coordinate plane.

- A2.FN.2:** Decide if a function is even or odd from a graph or an algebraic expression.
- A2.FN.3:** Explain how restricting the domain of a function allows the creation of its inverse.
- A2.FN.4:** Write and graph the inverse of a given function; understand that the graph of an inverse function is a reflection of the function over the line $y = x$.

Linear Functions, Equations, and Inequalities

Arithmetic Sequences

Students use arithmetic sequences to model problems.

- A2.LFE.1:** Write and use arithmetic sequences recursively and explicitly to model situations; translate between the two forms when given a graph, a description of the relationship, or two input-output pairs.

Matrices

Students perform operations and matrices.

A2.LFE.2: Multiply a matrix by a scalar.

A2.LFE.3: Add and subtract matrices.

Systems of Equations

Students solve systems of equations and inequalities.

A2.LFE.4: Solve systems of linear equations in three variables using matrices; use Gaussian elimination or technology.

Quadratic Functions & Equations

Create & Solve

Students create and solve problems that model quadratic relationships.

A2.QFE.1: Calculate and interpret the average rate of change of a quadratic function represented in a table, graph, or as an equation in the context of mathematical and real-world problems.

A2.QFE.2: Solve quadratic equations with complex number solutions.

A2.QFE.3: Represent and solve real-world problems using quadratic inequalities.

Logarithms

Students graph and interpret key features of equations that model quadratic relationships.

A2.QFE.4: Use the discriminant to determine the number and type of solutions of a quadratic equation.

A2.QFE.5: Sketch the graph of a quadratic function given a verbal description and show key features.

Graph & Key Features

Students solve systems of equations.

A2.QFE.6: Solve a system of equations consisting of a *linear equation* and a nonlinear *equation* in two variables by choosing substitution, elimination, or graphically (with or without technology) as appropriate for the system of equations.

Exponential & Logarithmic Functions & Equations

Create & Solve

Students create and solve problems that model exponential and logarithmic relationships.

A2.ELF.1: Use the properties of exponents to find equivalent expressions and to solve equations, including those involving rational exponents.

Algebra II Mathematics Standards

- A2.ELF.2:** Write and solve equations from real-world problems that can be represented as a logarithmic or exponential function in one variable.
- A2.ELF.3:** Write exponential equations that model the relationship between two quantities when given a graph, a written description, or a table of values within a mathematical or real-world context.
- A2.ELF.4:** Write and use geometric sequences recursively and explicitly to model situations; translate between the two forms when given a graph, a description of the relationship, or two input-output pairs.

Logarithms

Students define and use logarithms.

- A2.ELF.5:** Translate between logarithmic and exponential forms of an equation.
- A2.ELF.6:** Use properties of logarithms to simplify and evaluate logarithmic expressions, with or without technology.
- A2.ELF.7:** Use the inverse relationship between exponents and logarithms to solve problems.

Graph & Key Features

Students graph and interpret key features of exponential and logarithmic models.

- A2.ELF.8:** Determine the domain and range of logarithmic functions in mathematical problems.
- A2.ELF.9:** Determine reasonable domain and range values of logarithmic functions representing real-world situations, both continuous and discrete; interpret the solution as reasonable or unreasonable in context.
- A2.ELF.10:** Sketch the graph of an exponential function given a verbal description and show key features.
- A2.ELF.11:** Calculate and interpret the average rate of change of an exponential function represented in a table, graph, or as an equation in the context of mathematical and real-world problems.
- A2.ELF.12:** Graph exponential and logarithmic functions with and without context, identifying key features, and determining constraints in a given context.
- A2.ELF.13:** Graph and generalize the effect of transformations on exponential and logarithmic functions.
- Transformations include: stretches, compressions, vertical shifts, and horizontal shifts
- A2.ELF.14:** Given the graphs of exponential and logarithmic functions, explain the effects of the transformation from the parent function.
- Exponentials: $y = ab^x$, $a \neq 0$, $b > 0$, and $b \neq 1$
 - Logarithms: $y = \log_b(x)$, $b > 0$, $x > 0$ and $b \neq 1$

Polynomial, Rational, & Other Functions & Equations

Create & Solve

Students create and solve rational and polynomial equations.

- A2.PRF.1:** Write and solve equations from real-world problems that can be represented as a rational or square root function in one variable.
- A2.PRF.2:** Solve non-linear formulas for a specified variable.
- A2.PRF.3:** Find zeros of polynomial functions with a degree of 3 or higher when suitable factorizations are available in a real-world and mathematical context.

Algebra II Mathematics Standards

- A2.PRF.4:** Use zeros and an understanding of multiplicity to sketch a graph of a polynomial function with a degree of 3 or higher.
- A2.PRF.5:** Apply the Fundamental Theorem of Algebra to determine the number and potential types of roots of polynomial functions based on the degree of the polynomial.
- A2.PRF.6:** Solve rational and radical equations containing one variable specifying extraneous solutions.

Graph & Key Features

Students graph and identify key features of functions.

- A2.PRF.7:** Determine the domain and range of polynomial and rational functions in mathematical problems.
- A2.PRF.8:** Determine reasonable domain and range values of polynomial and rational functions representing real-world situations, both continuous and discrete; interpret the solution as reasonable or unreasonable in context.
- A2.PRF.9:** Interpret the key features of polynomial functions that model a relationship between two quantities in a given context; translate between different representations of the function, especially graphs, tables, and equations.
- A2.PRF.10:** Sketch the graph of a polynomial function given a verbal description and show key features.
- A2.PRF.11:** Calculate and interpret the average rate of change of polynomial functions represented in a table, graph, or as an equation in context of mathematical and real-world problems.
- A2.PRF.12:** Graph functions with and without context, identifying key features and determining constraints in a given context.
- Polynomial functions
 - Rational functions
 - Square root functions
 - Piecewise-defined functions
- A2.PRF.13:** Graph and generalize the effect of transformations on square root, cubic, and rational functions.
- Transformations include: stretches, compressions, vertical shifts, and horizontal shifts
- A2.PRF.14:** Given a graph, explain the effects of the transformation from the parent function.
- Functions include: square root $y = \sqrt{x}$, cubic $y = x^3$ and rational functions $y = \frac{1}{x}$

Factor Polynomials

Students factor polynomials.

- A2.PRF.15:** Apply the Remainder Theorem to factor polynomial functions.
- A2.PRF.16:** Verify polynomial identities and use them to describe numerical relationships.

Rational Expressions

Students perform operations on rational expressions.

- A2.PRF.17:** Apply understanding of rational number operations to add, subtract, multiply, and divide by nonzero rational expressions.
- A2.PRF.18:** Rewrite simple rational expressions in different forms.
- A2.PRF.19:** Divide polynomial expressions using inspection, long division, and synthetic division, with and without a remainder.

Systems of Equations

Students solve systems of equations.

- A2.PRF.20:** Explain why a solution to the equation $f(x) = g(x)$ is the x-coordinate where the y-coordinate of $f(x)$ and $g(x)$ are the same using graphs, tables, or approximations.
- Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, exponential, logarithmic, or rational and where at least one of the functions is not linear.

Statistics & Probability

Statistical Experiments & Studies

Students evaluate processes for statistical experiments, make inferences, and justify conclusions from statistical studies.

- A2.SP.1:** Use data from a random sample to make inferences about a population.
- A2.SP.2:** Compare theoretical and empirical probabilities using simulations.
- A2.SP.3:** Distinguish between sample surveys, experiments, and observational studies and explain the purpose of randomization in statistical studies.
- A2.SP.4:** Read and explain, in context, the validity of data from outside reports by:
- Identifying the variables as quantitative or categorical.
 - Describing how the data was collected.
 - Indicating any potential biases or flaws.
 - Identifying inferences the author of the report made from sample data.

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TECHNICAL MATH STANDARDS

Mathematical Processes & Modeling

Mathematical Processes & Modeling

Students use mathematical processes and models to acquire, demonstrate, and communicate mathematical understanding in real-world scenarios.

TM.MPM.1: Apply mathematics to problems arising in everyday life, workplace, and society.

TM.MPM.2: Use mathematical processes with algebraic formulas, numerical techniques, and graphs to solve real-world scenarios.

TM.MPM.3: Create mathematical models and use problem-solving skills, independently and as a collaborative team, for real-world scenarios to:

- Analyze given information or data
- Identify patterns or relationships
- Formulate a plan or strategy
- Estimate solutions
- Determine a solution
- Justify a solution and its reasonableness
- Describe limitations
- Identify how results are affected by changing parameters
- Suggest improvements

TM.MPM.4: Select appropriate tools and techniques to solve problems.

TM.MPM.5: Demonstrate effective use of resources.

TM.MPM.6: Use precise mathematical language and multiple representations to organize, record, and communicate mathematical ideas or solutions to solve real-world scenarios independently and collaboratively.

Numerical & Proportional Reasoning

Model with Estimation

Students use estimation to solve real-world problems and assess the reasonableness of a solution.

TM.NPR.1: Use estimation to identify the most reasonable mathematical solution.

TM.NPR.2: Use estimation and precision in real-world scenarios.

Proportional Reasoning

Students understand and reason about relationships between quantities.

TM.NPR.3: Solve real world-problems and interpret results involving calculations with percentages, decimals, and fractions.

- Conversions
- Percent change

Technical Mathematics Standards

- Percent of quantities

TM.NPR.4: Recognize, set up, and solve proportions from real-world scenarios.

TM.NPR.5: Utilize real-world scenarios requiring interpretation and comparison of various representations of rates, ratios, and proportions including scale drawings.

Comparison

Students use number sense and proportional reasoning to draw conclusions and communicate results.

TM.NPR.6: Compare magnitudes of numbers in context in different forms.

TM.NPR.7: Use dimensional analysis to solve problems involving multiple units of measurement.

Algebraic Relationships

Model with Functions

Students use mathematical concepts of algebra to explain linear and nonlinear applications in real-world scenarios.

TM.AR.1: Analyze and apply rate of change in terms of real-world scenarios.

TM.AR.2: Use concepts of systems of equations and inequalities to model and solve real-world scenarios.

TM.AR.3: Use linear programming with or without the use of technology to:

- Maximize or minimize (optimize) linear objective function in real-world scenarios.
- Determine the reasonableness of solutions.

Model with Data

Students use data to make decisions and predictions.

TM.AR.4: Collect and organize data, independently and as a collaborative team, to create appropriate graphical representations of real-world scenarios.

- Interpret graphical representations.
- Make predictions and decisions based on representations.
- Analyze results based on representations.

TM.AR.5: Create, interpret, and analyze best-fit models of linear and exponential functions to solve real-world scenarios.

- Interpret the constants, coefficients, and bases in the context of the data.
- Check the model for best fit and use the model, where appropriate, to draw conclusions or make predictions.

Measurement

Measurement & Measurement Tools

Students apply measurement and use measurement tools in real-world scenarios.

TM.MS.1: Convert between and within the metric system and the U.S. customary system in real-world scenarios.

Technical Mathematics Standards

TM.MS.2: Demonstrate mastery of utilizing measuring devices:

- Apply accurate readings of both metric and the U.S. customary measuring devices to a problem situation.
- Select and use appropriate measuring devices and understand the limitations of such devices for real-world scenarios.

TM.MS.3: Determine and use appropriate unit labels for real-world scenarios.

- Unit labels include: length, weight, capacity, distance, temperature, time, surface area, volume, area, perimeter.

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QUANTITATIVE REASONING STANDARDS

Modeling

Problem Solving

Students use appropriate mathematical models to solve problems involving everyday life, workplace, and society.

QR.MD.1: Use mathematical models to:

- Demonstrate understanding of the meaning of a solution in context.
- Identify when insufficient information is given to solve a problem.

QR.MD.2: Analyze mathematical models, describe limitations, and suggest improvements.

QR.MD.3: Use mathematical models created with spreadsheets or other tools to:

- Estimate solutions for contextual questions.
- Identify patterns.
- Identify how changing parameters affect results.

QR.MD.4: Use mathematical models to make decisions about purchases.

Bivariate Data Sets

Students use bivariate data sets to solve problems.

QR.MD.5: Select models for a given set of bivariate data sets; justify the choice.

QR.MD.6: Represent and use mathematical models for bivariate data sets to answer questions, draw conclusions, and make decisions.

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Numerical Reasoning

Number, Ratio, & Probability

Students use number sense and proportional reasoning in real-world settings to make and communicate decisions in order to draw conclusions based on quantitative analysis.

QR.NR.1: Solve real world problems and interpret results involving calculations with percentages, decimals, and fractions.

- Problem types include: conversions, percent change (absolute vs relative), and percent of quantities.

QR.NR.2: Use estimation in real world situations.

QR.NR.3: Numeric and contextual benchmarks:

- Identify appropriate numeric benchmarks for estimating calculations.
- Identify appropriate contextual benchmarks to compare to other numbers.

QR.NR.4: Compare magnitudes of numbers in context in different forms.

QR.NR.5: Use dimensional analysis to solve problems involving multiple units of measurement.

QR.NR.6: Solve real-world problems requiring interpretation and comparison of various representations of rates and ratios.

Quantitative Reasoning Standards

QR.NR.7: Distinguish between proportional and non-proportional real-world situations; when appropriate, apply proportional reasoning.

Statistics & Probability

Statistical

Students will draw conclusions, make decisions, and communicate based on understanding using statistical information.

QR.SP.1: Create charts, tables, and graphs of real world data with and without technology.

QR.SP.2: Analyze and interpret charts, tables, and graphs using real world data.

QR.SP.3: Compare and contrast charts, tables, and graphs using real world data.

QR.SP.4: Analyze statistical information from studies, surveys, and polls to make informed judgements as to the validity of claims or conclusions.

QR.SP.5: Make decisions about data summarized numerically using measures of center:

- Compare measures of center of two or more data sets.
- Interpret the differences in context.
- Justify the use of a chosen measure.

Probabilities

Students apply probabilistic reasoning to draw conclusions, to make decisions, and to evaluate outcomes of decisions.

QR.SP.6: Use probabilities to make and justify decisions about risks in everyday life.

QR.SP.7: Evaluate the validity of claims based on experimental and theoretical probabilities.

QR.SP.8: Apply rules of counting and probability to compute probabilities of compound real world events:

- Addition Rule of Probability
- Multiplication Rule of Probability
- Fundamental Counting Principle
- Permutation and combinations
- Visual representations

Personal Financial Literacy

Employment/Income

Students apply mathematics to make informed employment and income decisions.

QR.PF.1: Represent and analyze mathematical models for various types of income.

QR.PF.2: Represent and analyze various types of income deductions and employment forms.

QR.PF.3: Analyze expenses to create a household budget utilizing food, shelter, transportation, utilities, insurance, savings, and other expenses.

Investment

Students apply mathematics to make informed investment decisions.

Quantitative Reasoning Standards

QR.PF.4: Analyze various investment instruments for:

- Purposes
- Advantages
- Disadvantages
- Risks

Credit & Debt

Students apply mathematics to make informed credit and debt decisions.

QR.PF.5: Analyze the characteristics of various types of loans.

QR.PF.6: Apply appropriate models to determine the impact of the relationship among loan rates, the term of a loan, the principal amount of a loan, and payments.

QR.PF.7: Examine consumer protection, bankruptcy, and credit and debt management services for ways in which they affect household budgeting.

Business Financial Literacy

Business & Economics

Students understand the principles and mathematics in business as it applies to economics.

QR.BF.1: Use real-world data to determine how a product or service can be profitable in a community.

QR.BF.2: Determine fixed and variable expenses of running a business.

QR.BF.3: Calculate indices and solve problems using common indices:

- Consumer price index
- Cost of living index
- Determine what constitutes an index

QR.BF.4: Analyze how stock market averages and indices are calculated with technology.

QR.BF.5: Research how inflation changes the value of the U.S. Dollar over time.

QR.BF.6: Prepare for employment by analyzing job skills.

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ADVANCED TOPICS & MODELING IN MATHEMATICS STANDARDS

Functions

Interpreting Functions

Students extend previous knowledge of functions beyond linear and quadratic.

- AT.FN.1:** Interpret key features of graphs and tables in terms of two quantities, which extend to function families beyond linear and quadratic, that model a relationship between the quantities in a contextual application and/or student-generated data.
- AT.FN.2:** Analyze mathematical models, describe limitations, and suggest improvements.

Graphing Functions

Students analyze function using graphing.

- AT.FN.3:** Graph functions expressed symbolically and show key features of the graph using technology.
- Functions include exponential, logarithmic, and trigonometric functions.
- AT.FN.4:** Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions, with or without the appropriate technology.
- Contextual situations may include: cube root (e.g., minimizing packaging on cubic boxes, geostationary satellites), piecewise (e.g., postage stamp function, teacher salary, GPS for distance), and square root (distance via Pythagorean Theorem)
- AT.FN.5:** Graph polynomial functions, identifying zeros when suitable factorizations are available and showing end behavior, with or without the appropriate technology.
- AT.FN.6:** Graph rational functions, identifying zeros and asymptotes (vertical, horizontal, and/or oblique) when suitable factorizations are available and showing end behavior, with or without the appropriate technology.
- AT.FN.7:** Graph exponential and logarithmic functions, showing intercepts and end behavior.
- AT.FN.8:** Graph trigonometric functions showing period, midline, and amplitude.

Vectors & Matrices

Vectors

Students represent and model vector quantities and perform operations on vectors.

- AT.VM.1:** Recognize that vector quantities have both magnitude and direction and can be represented by directed line segments.
- AT.VM.2:** Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
- AT.VM.3:** Solve problems involving velocity and other quantities that can be represented by vectors.
- AT.VM.4:** Add and subtract vectors graphically and algebraically.
- AT.VM.5:** Given two vectors in magnitude and direction form, determine the magnitude and direction of the sum.
- AT.VM.6:** Multiply a vector by a scalar graphically and analytically; reverse their direction when possible.

AT.VM.7: Compute the magnitude and direction of a vector by multiplying a vector by a scalar.

Matrices

Students perform operations on matrices and use matrices in applications.

AT.VM.8: Use matrices to represent, list, describe and manipulate data with technology.

AT.VM.9: Multiply a matrix by a scalar.

AT.VM.10: Add and subtract matrices.

AT.VM.11: Multiply matrices, understanding that matrix multiplication for square matrices is not commutative.

AT.VM.12: Represent a system of linear equations as a single matrix equation in a vector variable.

AT.VM.13: Find and use the inverse of a matrix to solve systems of linear equations; solve 3×3 or greater systems of equations with technology.

Statistics & Probability

Expected Value

Students calculate and use expected values to solve problems.

AT.SP.1: Define a random variable for a quantity of interest 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.

AT.SP.2: Calculate the expected value for a random variable and describe the expected value as the mean of the probability distribution in context.

AT.SP.3: Create a probability distribution using theoretical probabilities; calculate the expected value.

AT.SP.4: Create a probability distribution using experimental or observational data; calculate the expected value.

Decisions Using Probability

Students use probability to evaluate outcomes of decisions.

AT.SP.5: Analyze the costs and benefits of possible outcomes of making a decision by assigning probabilities to particular payoff values; calculate expected values.

AT.SP.7: Analyze decisions and strategies using probability concepts.

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CALCULUS STANDARDS

Limits & Continuity

Identify and Calculate Limits

Students will determine the limit of a function at a value numerically, graphically, and analytically.

- C.LC.1:** Identify vertical asymptotes in rational and logarithmic functions by identifying locations where the function value approaches infinity; estimate limits numerically and graphically; calculate limits analytically:
- Algebraic simplification
 - Direct substitution
 - One-sided limits
 - Rationalization
- C.LC.2:** Calculate infinite limits and use the result to identify vertical asymptotes in rational and logarithmic functions.
- C.LC.3:** Calculate limits at infinity and use the result to identify horizontal asymptotes in rational and exponential functions.
- C.LC.4:** Calculate limits at infinity and use the result to identify unbounded behavior in rational, exponential, and logarithmic functions.
- C.LC.5:** Identify and classify graphically, algebraically, and numerically if a discontinuity is removable or non-removable; identify the three conditions that must exist in order for a function to be continuous at $x = a$:
- $f(a)$ is defined
 - The limit as x approaches a of $f(x)$ equals $f(a)$
 - The limit as x approaches a of $f(x)$ exists
- C.LC.6:** Apply the Intermediate Value Theorem for continuous functions.

Derivatives

Equation of a Tangent Line

Students will use derivatives to solve problems both theoretically and in real-world context.

- C.D.1:** Approximate the derivative:
- Graphically by finding the slope of a tangent line drawn to a curve at a given point.
 - Numerically by using the difference quotient.
- C.D.2:** Find the equation of the tangent line using the definition of derivative.
- C.D.3:** Establish and apply that differentiability implies continuity, but continuity does not necessarily imply differentiability.
- C.D.4:** Compare the characteristic of graphs of f and f' :
- Generate the graph of f given the graph of f' and vice versa.
 - Establish the relationship between the increasing and decreasing behavior of f and the sign of f' .
 - Identify maxima and minima as points where increasing and decreasing behavior change.
- C.D.5:** Apply the Mean Value Theorem on a given interval.

Calculus Standards

- C.D.6:** Compare the characteristic of graphs of f , f' , and f'' :
- Generate the graphs of f and f' given the graph of f'' and vice versa.
 - Establish the relationship between the concavity of f and the sign of f'' .
 - Identify points of inflection as points where concavity changes.
- C.D.7:** Find derivatives of functions using:
- Power rule
 - Product rule
 - Quotient rule
- C.D.8:** Find derivatives of:
- An implicitly defined equation
 - Composite functions using chain rule
 - Exponential and logarithmic functions
 - Functions requiring the use of more than one differentiation rule
- C.D.9:** Find the equation of:
- A line tangent to the graph of a function at a point
 - A normal line to the graph of a function at a point
- C.D.10:** Solve application problems involving:
- Optimization
 - Related rates
- C.D.11:** Interpret the derivative as a rate of change and varied applied contexts.
- Contexts include: velocity, speed, and acceleration

Integrals

Define the Definite Integral

Students will apply techniques of integration to solve problems, both theoretically and in contextual models that represent real-world phenomena.

- C.I.1:** Define the definite integral of the rate of change of a quantity over an interval interpreted as the change of the quantity over the interval.
- If f is a real, *continuous function* defined on $[a, b]$ and F is an antiderivative of f in $[a, b]$, then
$$\int_a^b f(x)dx = F(b) - F(a).$$
- C.I.2:** Determine the area between two curves and identify the definite integral as the area of the region bounded by two curves.
- C.I.3:** Apply the Fundamental Theorem of Calculus to solve contextual models that represent real-world phenomena.
- C.I.4:** Find the general solution to indefinite integrals.
- C.I.5:** Determine the antiderivative of a function using rules of basic differentiation, and solve problems using the techniques of antidifferentiation including but not limited to power rule and u -substitution.
- C.I.6:** Estimate definite integrals by using Riemann sums (left, right, midpoint, and trapezoidal) and identify the definite integral as a limit of Riemann sums.
- C.I.7:** Explore applications of integration.

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ALGEBRA III STANDARDS

Complex Numbers and Conic Sections

Complex Numbers

Students apply properties to complex numbers.

A3.CNC.1: Find the conjugate of a complex number; use conjugates to find quotients of complex numbers.

Conic Sections

Students relate the equations and graphs of conic sections.

A3.CNC.2: Generate an equivalent form of an equation for a conic section by completing the square to identify key characteristics.

- Conic sections include: circles, ellipses, parabolas, and hyperbolas

A3.CNC.3: Calculate infinite limits and use the result to identify vertical asymptotes in rational and logarithmic functions.

Functions

Compositions

Students compose and compare functions.

A3.FN.1: Combine functions by addition, subtraction, multiplication, division, and composition to model the relationship between two quantities in real-world and mathematical contexts.

Inverses

Students find inverse functions.

A3.FN.2: Verify if two functions are inverses of each other using composition of functions.

A3.FN.3: For a function with an inverse, explain how to read the ordered pairs of the inverse function when given a graph or table of values.

A3.FN.4: Construct an invertible function from a non-invertible function by restricting the domain.

Transformations

Students graph function transformations.

A3.FN.5: Graph and generalize the effect of transformations on quadratic, absolute value, square root, cube root, cubic, and step functions.

- Transformations include: stretches, compressions, vertical shifts, and horizontal shifts

A3.FN.6: Determine if a function is even, odd, or neither from a graph or an algebraic expression.

Sequences

Students use sequences to model and analyze mathematical situations.

- A3.FN.7:** Write and use arithmetic and geometric sequences recursively and explicitly to model situations, translating between the two forms.
- Forms include: when given a graph, a description of the relationship, or two input-output pairs

Matrices

Operations

Students represent and perform operations with matrices.

- A3.MAT.1:** Use matrices to describe, list, and manipulate data in different situations.
- A3.MAT.2:** Multiply matrices by scalars to solve real-world and mathematical problems.
- A3.MAT.3:** Add and subtract matrices.
- A3.MAT.4:** Multiply matrices, understanding that matrix multiplication for square matrices is not commutative.
- A3.MAT.5:** Calculate the determinant of a square matrix to determine if it has an inverse.

Systems

Students use matrices to solve systems of equations.

- A3.MAT.6:** Solve systems of linear equations using augmented matrices.

Exponential and Logarithmic Functions

Analyze & Interpret

Students analyze and interpret exponential and logarithmic functions.

- A3.ELF.1:** Analyze and interpret exponential and logarithmic functions, identifying key characteristics.
- Functions should be represented numerically, graphically, and algebraically.
 - Key features include asymptotes, end behavior, intercepts, domain, and range.

Solve

Students solve problems with exponential and logarithmic functions.

- A3.ELF.2:** Understand and apply the inverse relationship between exponents and logarithms to solve problems.

Polynomial & Rational Functions

Analyze, Interpret, & Graph

Students analyze, interpret, and graph polynomial and rational functions.

- A3.PRF.1:** Analyze and interpret polynomial functions, identifying key characteristics.
- Functions should be represented numerically, graphically, and algebraically.
 - Key features include end behavior, intercepts, domain, range, relative and absolute maximum and minimum, and intervals over which the function is increasing or decreasing.
- A3.PRF.2:** Analyze and interpret rational functions, identifying key characteristics.
- Functions should be represented numerically, graphically, and algebraically.
 - Key features include asymptotes (vertical, horizontal, and slant), end behavior, point discontinuities, intercepts, domain, and range.
- A3.PRF.3:** Graph rational functions showing zeros, asymptotes, and end behavior.
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PRE-CALCULUS STANDARDS

Vectors & Matrices

Recognize, Model, & Write Vectors

Students recognize, model, and write vector quantities.

PC.VM.1: Recognize that vector quantities have both magnitude and direction and can be represented by directed line segments.

PC.VM.2: Write vector quantities using appropriate symbols indicating magnitude and direction.

Vector Operations

Students perform operations involving vectors.

PC.VM.3: Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

PC.VM.4: Solve problems involving velocity and other quantities that can be represented by vectors.

PC.VM.5: Add and subtract vectors graphically and algebraically.

PC.VM.6: Multiply a vector by a scalar graphically and analytically; reverse their direction when possible.

Matrix Operations

Students represent and perform operations with matrices.

PC.VM.7: Use matrices to list, describe, and manipulate data with and without technology.

PC.VM.8: Multiply matrices, understanding that matrix multiplication for square matrices is not commutative.

PC.VM.9: 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.

PC.VM.10: Work with 2×2 matrices as transformations of the plane; interpret the absolute value of the determinant in terms of area

Trigonometry

Radians

Students understand, explain, and describe radian measure.

PC.TR.1: Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

PC.TR.2: Convert between radian and degree measure.

PC.TR.3: Explain how the unit circle can be used to model sine, cosine, tangent, secant, cosecant, and cotangent for all real numbers.

Unit Circle

Students use the unit circle to express and find exact values for trigonometric functions.

PC.TR.4: Construct special right triangles on the unit circle to find the exact values of sine, cosine, tangent for $\frac{\pi}{3}, \frac{\pi}{4}, \frac{\pi}{6}$, and $\frac{\pi}{2}$.

PC.TR.5: Use the unit circle to express the values of sine, cosine, and tangent for $\pi - x, \pi + x$, and $2\pi - x$ in terms of their exact values for x , where x is one of these values: $\frac{\pi}{3}, \frac{\pi}{4}, \frac{\pi}{6}$, and $\frac{\pi}{2}$.

Identities, Formulas, & Laws

Students develop and apply identities, formulas, and laws using trigonometry.

PC.TR.6: Develop the Pythagorean identity, $\sin^2(\theta) + \cos^2(\theta) = 1$.

PC.TR.7: Apply the Pythagorean identity to find the remaining trigonometric functions when given $\sin(\theta), \cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.

PC.TR.8: Develop addition, subtraction, double, and half-angle formulas for sine, cosine, and tangent and use them to solve problems, including verifying other identities.

PC.TR.9: Develop the formula for the area of a triangle, $A = \left(\frac{1}{2}\right) ab \sin C$, using trigonometry.

PC.TR.10: Develop and apply the Law of Sines and the Law of Cosines to solve real-world and mathematical problems including finding unknown measurements in right and non-right triangles.

PC.TR.11: Define and use reciprocal functions, cosecant, secant, and cotangent to solve problems.

Solve & Graph

Students explore, solve, and sketch the graphs of periodic trigonometric functions.

PC.TR.12: Explain whether a trigonometric function is even or odd and recognize the periodicity of the graph using the unit circle.

PC.TR.13: Graph trigonometric and inverse trigonometric functions and show period, midline, and amplitude.

PC.TR.14: Select a trigonometric function that models real-world contexts.

PC.TR.15: Explain how restricting the domain of a trigonometric function allows the creation of its inverse.

PC.TR.16: Solve and evaluate the solution of trigonometric equations in real-world contexts; interpret the solution in terms of its context.

PC.TR.17: Recognize that some trigonometric equations have infinitely many solutions and be able to state a general formula to represent the infinite solutions.

PC.TR.18: Calculate and interpret the average rate of change over a specified interval of a trigonometric function represented in a table, graph, or as an equation in the context of real-world and mathematical problems.

Conic Sections

Derive Equations

Students derive equations for conic sections.

Pre-Calculus Standards

PC.CS.1: Derive the general form of the equation of a circle using the Distance Formula or Pythagorean Theorem.

PC.CS.2: Derive the equation of a parabola given a focus and directrix.

PC.CS.3: Derive the equations of ellipses and hyperbolas given the foci using the Distance Formula.

Explore Equations

Students use matrices to solve systems of equations.

PC.CS.4: Find the equations for the asymptotes of a hyperbola.

PC.CS.5: Generate an equivalent form of an equation for a conic section by completing the square to identify key characteristics.

- Conic sections include: circles, ellipses, parabolas, and hyperbolas

PC.CS.6: Identify, graph, write, and analyze equations of each type of conic section using properties and technology when appropriate.

- Conic sections include: circles, ellipses, parabolas, and hyperbolas
- Properties include: symmetry, intercepts, foci, asymptotes, and eccentricity

Systems of Equations & Inequalities

Students solve systems of equations and inequalities involving conic sections.

PC.CS.7: Solve systems of equations and inequalities involving conics and other types of equations, with and without technology.

- Equations include: conic-conic and conic-linear

Functions

Solve Problems

Students derive and apply functions.

PC.FN.1: Understand that sequences are functions, sometimes defined recursively, whose domains are a subset of the integers.

PC.FN.2: Derive the formula for the sum of a finite geometric series; apply the formula to solve conceptual problems.

PC.FN.3: Apply the Binomial Theorem for the expansion of $(a + b)^n$ in powers of a and b for a positive integer n , where a and b are any number.

PC.FN.4: Build functions to model real-world contexts using algebraic operations on functions and composition, with and without appropriate technology.

Explore Graphing

Students graph and interpret functions.

PC.FN.5: Graph power and polynomial functions, identify zeros (when suitable factorizations are available), and show end behavior.

PC.FN.6: Graph rational functions, identify zeros and asymptotes (when suitable factorizations are available), and show end behavior.

- Asymptotes include: horizontal, vertical, and oblique

PC.FN.7: Graph exponential and logarithmic functions; show intercepts and end behavior.

PC.FN.8: Compare key features of two functions each represented in a different way.

- Representations include: algebraic, graphic, numeric in tables, and verbal descriptions

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STATISTICS STANDARDS

Making Inferences & Justifying Conclusion

Surveys, Experiments, & Observational Data

Students make inferences and justify conclusions from sample surveys, experiments, and observational studies.

- S.MI.1:** Estimate a population mean or proportion from a sample survey; develop a margin of error through the use of simulation models for random sampling.
 - S.MI.2:** Calculate the standardized test statistic and P-value for a test about a population proportion and a population mean; determine if the sample data provides convincing evidence against a parameter claim.
 - S.MI.3:** Compare two treatment groups in an experiment and determine if the difference in parameters is significant by calculating the standardized test statistics and P-value.
-

Conditional Probability & Rules of Probability

Compute Probability of Compound Events

Students use the rules of probability to compute probabilities of compound events.

- S.RP.1:** Determine unions or intersections of events in a sample space; determine complements of events.
- S.RP.2:** Identify the two components that make up a legitimate probability model/distribution.

Independence & Conditional Probability

Students understand and use independence and conditional probability to interpret data.

- S.RP.3:** Determine if two events, A and B, are independent when given the probabilities of A and B.
 - S.RP.4:** Calculate and use conditional probabilities to determine if events are independent.
 - S.RP.5:** Create and analyze two-way frequency tables of data to calculate marginal, joint, and conditional probabilities.
 - S.RP.6:** Using a two-way table, determine if two events are independent.
 - S.RP.7:** Explain conditional probability and independence using everyday language in a variety of real-world contexts.
 - S.RP.8:** Find the conditional probability of A given B, $P(A|B)$, and interpret the answer in terms of the model, including two-way frequency tables and Venn diagrams.
 - S.RP.9:** Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$ and interpret the answer.
 - S.RP.10:** Identify whether or not two events are mutually exclusive / disjoint.
 - S.RP.11:** Apply the general Multiplication Rule, $P(A \text{ and } B) = P(A)P(B|A) = P(B)P(A|B)$ and interpret the answer.
 - S.RP.12:** Compute the probability of compound events and solve problems using combinations, permutations, Venn Diagrams, and Tree Diagrams.
-

Using Probability to Make Decisions

Expected Values

Students calculate and use expected values of random variables to solve problems.

- S.PMD.1:** Define a random variable for a quantity of interest 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.
- S.PMD.2:** Calculate the expected value for a discrete random variable; describe the expected value as the mean or typical value of the probability distribution in context.
- S.PMD.3:** Create a probability distribution of a discrete random variable using theoretical probabilities and use the probability distribution to calculate the probability of an event.
- S.PMD.4:** Create a probability distribution for a discrete random variable using experimental or observational data; calculate the expected value.
- S.PMD.5:** Use probability density models such as the normal curve and uniform density curve to model real-world data; calculate probabilities of continuous random variables using these models.

Outcomes of Decision

Students evaluate outcomes of decisions using probability.

- S.PMD.6:** Analyze the costs and benefits of possible outcomes of making a decision by assigning probabilities to particular payoff values of a discrete random variable and calculate expected values.

Collecting Data & Data Bias

Data Collection

Students explore best practices of collecting data while identifying possible sources of bias in data collection methods.

- S.CD.1:** Describe how to take a simple random sample using technology or a random number table.
- S.CD.2:** Use randomization strategies to ensure random selection processes are fair.
- S.CD.3:** Understand that certain types of sampling methods may lead to bias, such as convenience and voluntary samples.

Displaying & Describing Distributions of Data

Data Representation

Students represent raw data in tabular and graphical form to describe features of the data and summarize trends.

- S.DD.1:** Distinguish between categorical and quantitative data.
- S.DD.2:** Determine if there is an association between two quantitative variables using the correlation coefficient and scatter plots.
- S.DD.3:** Model real-world data using least squares regression techniques.

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CRITICAL ALGEBRA I MATH STANDARDS

Critical Algebra I Math Standards are composed of the Algebra I standards and supporting standards from previous grades. The supporting standards are located at the end of this course.

Expressions

Polynomials, Roots, & Exponent Laws

Students simplify algebraic and numerical expressions.

- A1.EX.1:** Add, subtract, and multiply polynomials; compare the system of polynomials to the system of integers when performing operations.
- Supporting standards: 6.ALG.5, 7.ALG.1, 8.NCC.3
- A1.EX.2:** Simplify and perform operations with radical expressions without variables; rationalizing denominators should not include conjugates.
- Supporting standards: 6.NCC.11, 8.NCC.8
- A1.EX.3:** Simplify algebraic expressions using the laws of exponents.
- Supporting standards: 6.ALG.3, 7.NCC.7, 7.NCC.8, 8.NCC.3
- A1.EX.4:** Interpret the parts of expressions such as terms, factors, and coefficients in terms of a real-world context.
- Supporting standards: 5.CAR.13, 6.ALG.1, 6.ALG.2

Functions

Domain & Range, Function Notation

Students understand the concept of a function, domain and range, and use function notation; students use function notation to solve problems.

- A1.FN.1:** Explain that a function assigns each element in the domain to exactly one element in the range.
- Supporting standards: 7.ALG.5, 8.FN.3
- A1.FN.2:** Use function notation to represent functions, understanding that if f is a function and x is an element of its domain, then $f(x)$ represents the output of f corresponding to the input x .
- Supporting standards: 7.ALG.5, 8.FN.3
- A1.FN.3:** Graph functions given in function notation, understanding that the graph contains the points $(x, f(x))$.
- Supporting standards: 5.CAR.12, 6.ALG.3, 6.ALG.6, 7.NCC.9
- A1.FN.4:** Evaluate functions expressed in function notation for one or more elements in their domains (inputs); use function notation to describe a contextual situation.
- Supporting standards: 7.ALG.5, 8.FN.3

Construct & Compare

Students construct and compare linear, quadratic, and exponential models and solve problems.

A1.FN.5: Differentiate between real-world scenarios that can be modeled by exponential or linear functions by determining whether the relationship has a common difference or a common ratio.

- Supporting standards: 7.PR.1, 7.PR.4, 7.PR.5, 7.PR.6, 8.FN.5, 8.FN.6, 8.FN.7, 8.FN.8, 8.FN.9

A1.FN.6: Compare the growth pattern of exponential to linear or quadratic functions using graphs and tables and recognize how exponential growth exceeds other functions.

- Supporting standards: 7.PR.1, 7.PR.4, 7.PR.5, 7.PR.6, 8.FN.5, 8.FN.6, 8.FN.7, 8.FN.8, 8.FN.9

Linear Functions, Equations, & Inequalities

Create & Solve

Students create and solve equations that model linear relationships.

A1.LFE.1: Represent and solve real-world problems, using linear expressions, equations, and inequalities in one variable.

- Supporting standards: 6.ALG.3, 6.ALG.4, 6.ALG.7, 6.ALG.8, 7.ALG.1, 7.ALG.2, 7.ALG.3, 7.NCC.9, 7.PR.6, 8.FN.6, 8.FN.7, 8.ALG.1, 8.ALG.2

A1.LFE.2: Construct linear functions from arithmetic sequences with and without context.

- Supporting standards: 7.PR.1, 7.PR.4, 7.PR.6, 8.FN.6, 8.FN.7

A1.LFE.3: Solve linear formulas for a specified variable.

- Supporting standards: 6.ALG.3, 6.ALG.4, 6.ALG.7, 6.ALG.8, 7.ALG.1, 7.ALG.2, 7.ALG.3, 7.NCC.9, 7.PR.6, 8.FN.6, 8.FN.7, 8.ALG.1, 8.ALG.2

A1.LFE.4: Solve linear equations, linear inequalities, and absolute value equations in one variable, including those with rational number coefficients, and variables on both sides of the equal or inequality sign; solve them fluently, explaining the process used.

- Supporting standards: 6.NCC.4, 6.ALG.3, 6.ALG.4, 6.ALG.7, 6.ALG.8, 7.ALG.1, 7.ALG.2, 7.ALG.3, 7.NCC.9, 7.PR.6, 8.FN.6, 8.FN.7, 8.ALG.1, 8.ALG.2

Interpret Key Features

Students interpret key features of equations that model linear relationships.

A1.LFE.5: Determine the domain and range of linear functions in mathematical problems.

- Supporting standards: 7.ALG.4, 8.FN.3, 8.FN.8

A1.LFE.6: Determine reasonable domain and range values of linear functions representing real-world situations, both continuous and discrete; interpret the solution as reasonable or unreasonable in context.

- Supporting standards: 7.ALG.4, 8.FN.3, 8.FN.8

A1.LFE.7: Interpret the key features of a linear and absolute value functions that models a relationship between two quantities in a given context.

- Supporting standards: 5.GM.8, 6.NCC.4, 6.PR.2, 7.PR.1, 7.NCC.3, 7.PR.7, 7.ALG.5, 8.FN.4, 8.FN.5, 8.FN.6, 8.FN.7, 8.FN.8, 8.FN.9

A1.LFE.8: Flexibly use different representations of a linear function, including graphs, tables, and equations.

- Supporting standards: 5.GM.8, 6.NCC.4, 6.PR.2, 7.PR.1, 7.NCC.3, 7.PR.7, 7.ALG.5, 8.FN.4, 8.FN.5, 8.FN.6, 8.FN.7, 8.FN.8, 8.FN.9

A1.LFE.9: Calculate and interpret the rate of change of a linear function represented in a table, graph, or as an equation in context of real-world and mathematical problems.

Critical Algebra I Standards

- Supporting standards: 5.GM.8, 6.NCC.4, 6.PR.2, 7.PR.1, 7.NCC.3, 7.PR.7, 7.ALG.5, 8.FN.4, 8.FN.5, 8.FN.6, 8.FN.7, 8.FN.8, 8.FN.9

A1.LFE.10: Translate among equivalent forms of equations for linear functions, including standard, point-slope, and slope-intercept forms; recognize that each form reveals key features in a given context.

- Supporting standards: 6.ALG.4, 7.NCC.9, 7.ALG.1

Systems of Equations & Inequalities

Students solve systems of equations and inequalities.

A1.LFE.11: Solve systems of linear equations by substitution, elimination, and graphing with and without a real-world context; understand that the solutions will be the same regardless of the method for solving.

- Supporting standards: 6.ALG.1, 6.ALG.2, 6.ALG.3, 6.ALG.4, 6.ALG.5, 7.ALG.1, 7.ALG.2, 8.ALG.1, 8.ALG.3

A1.LFE.12: Solve a system of equations consisting of a linear equation and a quadratic equation in two variables graphically with the assistance of technology.

- Supporting standards: 6.ALG.1, 6.ALG.2, 6.ALG.3, 6.ALG.4, 6.ALG.5, 7.ALG.1, 7.ALG.2, 8.ALG.1, 8.ALG.3

A1.LFE.13: Explain why a solution to the equation $f(x) = g(x)$ is the x-coordinate where the y-coordinate of $f(x)$ and $g(x)$ are the same using graphs, tables, or approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, quadratic, absolute value, and exponential.

- Supporting standards: 6.ALG.1, 6.ALG.2, 6.ALG.3, 6.ALG.4, 6.ALG.5, 7.ALG.1, 7.ALG.2, 8.ALG.1, 8.ALG.3

A1.LFE.14: Solve linear inequalities and systems of linear inequalities in two variables by graphing.

- Supporting standards: 6.ALG.1, 6.ALG.2, 6.ALG.3, 6.ALG.4, 6.ALG.5, 6.ALG.8, 7.ALG.1, 7.ALG.2, 7.ALG.3, 8.ALG.1, 8.ALG.2, 8.ALG.3

Graphing & Transformations

Students graph linear functions, equations, and inequalities.

A1.LFE.15: Write linear equations that model the relationship between two quantities and produce a graph of the equation.

- Supporting standards: 5.GM.7, 5.GM.8, 6.GM.4, 6.ALG.1, 6.ALG.2, 6.ALG.3, 7.ALG.2, 7.ALG.4, 7.PR.6, 8.ALG.1, 8.ALG.2, 8.FN.9

A1.LFE.16: Graph linear functions expressed as an equation and show intercepts of the graph without technology.

- Supporting standards: 5.GM.7, 5.GM.8, 6.GM.4, 7.ALG.1, 7.PR.4, 8.FN.1, 8.FN.5, 8.FN.6, 8.FN.7

A1.LFE.17: Graph absolute value functions expressed as an equation with and without technology, showing intercepts and end behavior.

- Supporting standards: 5.GM.7, 5.GM.8, 6.GM.4, 6.NCC.4, 7.NCC.3, 7.ALG.1, 7.PR.4, 8.FN.1, 8.FN.5, 8.FN.6, 8.FN.7

A1.LFE.18: Graph and generalize the effect of transformations on linear and absolute value functions.

- Transformations include: stretches, compressions, vertical, and horizontal
- Supporting standards: 5.GM.7, 5.GM.8, 6.GM.4, 6.NCC.4, 7.NCC.3, 7.ALG.1, 7.PR.4, 8.FN.1, 8.FN.5, 8.FN.6, 8.FN.7

A1.LFE.19: Given the graph of a linear function, explain the effects of the transformation from the parent function, $y = x$.

- Supporting standards: 5.GM.7, 5.GM.8, 6.GM.4, 7.ALG.1, 7.PR.4, 8.FN.1, 8.FN.5, 8.FN.6, 8.FN.7

Statistical Relationships

Students explore linear statistical relationships.

- A1.LFE.20:** Write linear functions that provide a reasonable fit to data and use them to make predictions, with and without technology; interpret the slope and y-intercept in context.
- Supporting standards: 8.SP.1, 8.SP.2
- A1.LFE.21:** Calculate, using technology, the correlation coefficient between two quantitative variables and interpret this quantity as a measure of the strength of the linear association.
- Supporting standards: 8.SP.1, 8.SP.2
- A1.LFE.22:** Compare and contrast correlation and causation in real-world problems.
- Supporting standards: 8.SP.1, 8.SP.2

Quadratic Functions & Equations

Create & Solve

Students create and solve equations that model quadratic relationships.

- A1.QFE.1:** Represent and solve real-world problems using quadratic expressions and equations in one variable.
- Supporting standards: 6.ALG.3, 6.ALG.4, 6.ALG.7, 6.ALG.8, 7.ALG.1, 7.ALG.2, 7.ALG.3, 7.NCC.9, 7.PR.6, 8.NCC.7, 8.NCC.8, 8.FN.6, 8.FN.7, 8.ALG.1, 8.ALG.2
- A1.QFE.2:** Write quadratic equations with real number solutions that model the relationship between two quantities and produce a graph of the equation.
- Supporting standards: 5.GM.7, 5.GM.8, 6.GM.4, 6.ALG.1, 6.ALG.2, 6.ALG.3, 7.ALG.2, 7.ALG.4, 7.PR.6, 8.ALG.1, 8.ALG.2, 8.FN.9
- A1.QFE.3:** Solve quadratic equations with real number solutions, containing one variable, including those with variables on both sides of the equal sign. Equations should be solved by:
- Graphing,
 - Factoring (including perfect square trinomials and difference of squares binomials),
 - Using the quadratic formula,
 - Completing the square, or
 - Taking the square root.
 - Supporting standards: 6.ALG.1, 6.ALG.2, 6.ALG.3, 6.ALG.4, 6.ALG.5, 7.ALG.1, 7.ALG.2, 7.NCC.9, 8.ALG.1, 8.ALG.2, 8.NCC.7, 8.NCC.8

Interpret Key Features

Students interpret key features of equations that model quadratic relationships.

- A1.QFE.4:** Determine the domain and range of quadratic functions in mathematical problems.
- Supporting standards: 7.ALG.4, 8.FN.3, 8.FN.8
- A1.QFE.5:** Determine reasonable domain and range values of quadratic functions representing real-world situations, both continuous and discrete; interpret the solution as reasonable or unreasonable in context.
- Supporting standards: 7.ALG.4, 8.FN.3, 8.FN.8

Critical Algebra I Standards

- A1.QFE.6:** Interpret the key features of a quadratic function that models a relationship between two quantities in a given context.
- Supporting standards: 5.GM.8, 6.NCC.4, 6.PR.2, 7.PR.1, 7.NCC.3, 7.PR.7, 7.ALG.5, 8.FN.4, 8.FN.5, 8.FN.6, 8.FN.7, 8.FN.8, 8.FN.9
- A1.QFE.7:** Flexibly use different representations of a quadratic function, including graphs, tables, and equations.
- Supporting standards: 5.GM.8, 6.NCC.4, 6.PR.2, 7.PR.1, 7.NCC.3, 7.PR.7, 7.ALG.5, 8.FN.4, 8.FN.5, 8.FN.6, 8.FN.7, 8.FN.8, 8.FN.9
- A1.QFE.8:** Explain how each form of a quadratic expression (standard, factored, and vertex form) identifies different key attributes, using the different forms to interpret quantities in context.
- Supporting standards: 6.ALG.4, 7.NCC.9, 7.ALG.1, 8.NCC.3, 8.NCC.7, 8.NCC.8, 8.FN.5
- A1.QFE.9:** Use factoring and completing the square to create equivalent forms of quadratic functions to reveal key attributes.
- Supporting standards: 6.ALG.1, 6.ALG.2, 6.ALG.3, 6.ALG.4, 6.ALG.5, 7.ALG.1, 7.ALG.2, 7.NCC.9, 8.ALG.1, 8.ALG.2, 8.NCC.3, 8.NCC.7, 8.NCC.8, 8.FN.5

Graphing & Transformations

Students graph quadratic functions and explore different transformations of $f(x) = x^2$.

- A1.QFE.10:** Graph quadratic functions given as an equation or in function notation, labeling key attributes, without technology.
- Supporting standards: 5.GM.7, 5.GM.8, 6.GM.4, 7.ALG.1, 7.PR.4, 8.FN.1, 8.FN.5, 8.FN.6, 8.FN.7
- A1.QFE.11:** Graph and describe the effect of transformations on quadratic functions.
- Transformations include: stretches, compressions, vertical, and horizontal
 - Supporting standards: 5.GM.7, 5.GM.8, 6.GM.4, 7.ALG.1, 7.PR.4, 8.FN.1, 8.FN.5, 8.FN.6, 8.FN.7
- A1.QFE.12:** Given the graph of a quadratic function, explain the effects of the transformation from the parent function, $y = x^2$.
- Supporting standards: 5.GM.7, 5.GM.8, 6.GM.4, 7.ALG.1, 7.PR.4, 8.FN.1, 8.FN.5, 8.FN.6, 8.FN.7

Statistical Relationships

Students explore quadratic statistical relationships.

- A1.QFE.13:** Write quadratic functions that provide a reasonable fit to data and use them to make predictions with technology.
- Supporting standards: 8.SP.1, 8.SP.2

Exponential Functions & Equations

Create & Solve

Students create and solve problems that model exponential relationships.

- A1.EFE.1:** Represent and solve real-world problems, using exponential equations in one variable.
- Supporting standards: 6.ALG.3, 6.ALG.4, 6.ALG.7, 6.ALG.8, 7.ALG.1, 7.ALG.2, 7.ALG.3, 7.NCC.9, 7.PR.6, 8.FN.6, 8.FN.7, 8.ALG.1, 8.ALG.2

Critical Algebra I Standards

- A1.EFE.2:** Represent real-world problems (growth, decay, and compound interest), using exponential equations.
- Supporting standards: 6.ALG.3, 6.ALG.4, 6.ALG.7, 6.ALG.8, 7.ALG.1, 7.ALG.2, 7.ALG.3, 7.NCC.9, 7.PR.6, 8.FN.6, 8.FN.7, 8.ALG.1, 8.ALG.2
- A1.EFE.3:** Construct exponential equations from geometric sequences with and without context.
- Supporting standards: 6.ALG.3, 6.ALG.4, 6.ALG.7, 6.ALG.8, 7.ALG.1, 7.ALG.2, 7.ALG.3, 7.NCC.9, 7.PR.6, 8.FN.6, 8.FN.7, 8.ALG.1, 8.ALG.2

Interpret Key Features

Students interpret key features of equations that model exponential relationships.

- A1.EFE.4:** Determine the domain and range of exponential functions in mathematical problems.
Supporting standards: 7.ALG.4, 8.FN.3, 8.FN.8
- A1.EFE.5:** Determine reasonable domain and range values of exponential functions representing real-world situations, both continuous and discrete; interpret the solution as reasonable or unreasonable in context.
- Supporting standards: 7.ALG.4, 8.FN.3, 8.FN.8
- A1.EFE.6:** Interpret the key features of an exponential function that models a relationship between two quantities in a given context.
- Supporting standards: 5.GM.8, 6.NCC.4, 6.PR.2, 7.PR.1, 7.NCC.3, 7.PR.7, 7.ALG.5, 8.FN.4, 8.FN.5, 8.FN.6, 8.FN.7, 8.FN.8, 8.FN.9
- A1.EFE.7:** Flexibly use different representations of an exponential function, including graphs, tables, and equations.
- Supporting standards: 5.GM.8, 6.NCC.4, 6.PR.2, 7.PR.1, 7.NCC.3, 7.PR.7, 7.ALG.5, 8.FN.4, 8.FN.5, 8.FN.6, 8.FN.7, 8.FN.8, 8.FN.9
- A1.EFE.8:** Interpret the quantities in an exponential equation in the context of a real-world problem, including growth, decay, and compound interest.
- Supporting standards: 5.GM.8, 6.NCC.4, 6.PR.2, 7.PR.1, 7.NCC.3, 7.PR.7, 7.ALG.5, 8.FN.4, 8.FN.5, 8.FN.6, 8.FN.7, 8.FN.8, 8.FN.9

Graphing

Students graph exponential functions.

- A1.EFE.9:** Graph exponential functions that model real-world problems (growth, decay, and compound interest), showing key attributes.
- Supporting standards: 5.GM.7, 5.GM.8, 6.GM.4, 7.ALG.1, 7.PR.4, 8.FN.1, 8.FN.5, 8.FN.6, 8.FN.7

Statistical Relationships

Students explore exponential statistical relationships.

- A1.EFE.10:** Write exponential functions that provide a reasonable fit to data and use them to make predictions with technology.
- Supporting standards: 8.SP.1, 8.SP.2

Statistics & Probability

Numerical Data

Students summarize and describe distributions.

- A1.SP.1:** Use box plots and histograms to determine the statistics appropriate to the shape of the data distribution; compare the center and spread of two or more data sets.
- Supporting standards: 6.SP.2, 6.SP.3, 6.SP.4, 6.SP.5, 6.SP.6, 6.SP.7, 6.SP.8, 7.SP.1, 7.SP.3, 7.SP.4
- A1.SP.2:** Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points.
- Supporting standards: 6.SP.4, 6.SP.5, 6.SP.7

Bivariate Data

Students will investigate patterns of association in bivariate data.

- A1.SP.3:** Summarize data from two categorical variables in a frequency table; interpret relative frequencies in the context of the data, recognizing data trends and associations.
- Supporting standards: 6.SP.8, 7.SP.1, 8.SP.3

Critical Algebra I Supporting Standards:

Fifth Grade

- 5.CAR.12:** Evaluate numerical expressions with parentheses or brackets and exponents with the base of ten, using the Order of Operations.
- 5.CAR.13:** Write simple expressions that record calculations with numbers, interpreting numerical expressions without evaluating them.
- 5.GM.7:** Graph points with whole number coordinates on a coordinate plane in the first quadrant, explaining how the coordinates relate to the horizontal and vertical axes to describe the location of points in the plane.
- 5.GM.8:** Represent real-world and mathematical problems by graphing points in the first quadrant on a coordinate plane, interpreting coordinate values of points in the context of the situation.

Sixth Grade

- 6.NCC.4:** Interpret the absolute value of numbers for positive or negative quantities in a real-world context.
- 6.NCC.11:** Solve real-world and mathematical problems with the greatest common factor of two whole numbers less than or equal to 100.
- 6.PR.2:** Calculate unit rates to include unit pricing and constant speed.
- 6.ALG.1:** Read and write expressions in real-world or mathematical problems in which letters stand for numbers.
- 6.ALG.2:** Use mathematical terms to identify parts of an expression, including the names of operations, terms, factors, coefficients, variables, and constants.
- 6.ALG.3:** Write and evaluate expressions for given values of variables, using order of operations, including expressions with whole number exponents.

Critical Algebra I Standards

- 6.ALG.4:** Generate equivalent expressions by applying the associative, commutative, distributive, and identity properties.
- 6.ALG.5:** Identify when two expressions are equivalent by using properties of operations including like terms.
- 6.ALG.6:** Use substitution to determine if a given value in a specified set makes an equation or inequality true.
- Include the following inequality symbols: $<$, $>$, \leq , \geq , \neq
- 6.ALG.7:** Write and solve one-step equations in real-world and mathematical problems, involving positive rational numbers and zero.
- 6.ALG.8:** Write, solve, and graph one-step inequalities in real-world and mathematical problems.
- 6.GM.4:** Find and graph pairs of rational numbers in all four quadrants of the coordinate plane in real-world and mathematical problems.
- 6.SP.2:** Calculate and interpret any measure of center (mean, median, and mode) of a numerical data set.
- 6.SP.3:** Determine which measure of center (mean or median) is more appropriate to describe the center of data and justify the choice.
- 6.SP.4:** Describe how the mean or median is affected by outliers of a numerical data set.
- 6.SP.5:** Calculate and interpret the measure of variation [range and interquartile range (IQR)] of a numerical data set.
- 6.SP.6:** Determine which measure of variation (range or interquartile range) is more appropriate to describe the shape; justify the choice.
- 6.SP.7:** Represent numerical data on a number line, histogram, and box plot.
- 6.SP.8:** Calculate the relative frequency of an interval of data values when given a histogram.

Seventh Grade

- 7.NCC.3:** Demonstrate in real-world contexts the distance between two rational numbers on the number line as the absolute value of their differences.
- 7.NCC.7:** Use addition and subtraction with rational numbers in any form to solve multi-step problems in real-world and mathematical contexts.
- 7.NCC.8:** Use multiplication and division with rational numbers in any form to solve multi-step problems in real-world and mathematical contexts.
- 7.NCC.9:** Apply operations with rational numbers involving the order of operations, involving nested grouping symbols.
- 7.PR.1:** Determine the unit rate (constant of proportionality) from tables, graphs, equations, diagrams, or verbal descriptions of proportional relationships.
- 7.PR.4:** Determine whether two quantities represent proportional relationships by using equivalent ratios in a table and by graphing on a coordinate plane.
- 7.PR.5:** Compare two different proportional relationships represented in different forms.
- 7.PR.6:** Create equations in the form of $y = mx$ from tables, verbal descriptions, or graphs.
- 7.PR.7:** Given a graph with a proportional relationship, explain the meaning of a point (x, y) on the graph, including the origin $(0, 0)$ and the unit rate $(1, r)$.
- 7.ALG.1:** Generate and justify equivalent expressions, using properties of operations to add, subtract, factor, and expand linear expressions with rational coefficients within mathematical and real-world problems.
- 7.ALG.2:** Model and solve fluently two-step equations in real-world or mathematical problems.
- 7.ALG.3:** Create, solve, and graph two-step inequalities in real-world and mathematical problems in the forms $px \pm q > r$, $px \pm q < r$, $px \pm q \geq r$, and $px \pm q \leq r$.
- 7.ALG.4:** Write an equation to express two quantities in terms of the dependent and independent variables.
- 7.ALG.5:** Describe the relationship between the dependent and independent variables in an equation using tables and graphs, relating these to the equation.
- 7.SP.1:** Interpret data displayed in a histogram and box plot to answer questions about the data.

- 7.SP.3:** Graph two numerical data sets and compare their variability.
- Variability includes: range, interquartile range, or mean absolute deviation
- 7.SP.4:** Select an appropriate measure(s) of center or variability and draw valid comparative inferences for two data sets.

Eighth Grade

- 8.NCC.3:** Know and apply the properties of integer exponents to generate equivalent numerical expressions.
- 8.NCC.7:** Solve equations in the form of $x^2 = p$ or $x^3 = p$ where p is a positive rational number.
- 8.NCC.8:** Evaluate square roots of perfect squares and cube roots of perfect cubes.
- 8.FN.1:** Graph proportional relationships, interpreting the unit rate as the slope of the graph.
- 8.FN.3:** Determine whether a relation is a function or not when given a function map, table, graph, equation, or set of ordered pairs.
- 8.FN.4:** Compare the rate of change (slope) and y-intercept (initial value) of two linear functions each represented in different forms.
- Functions are represented algebraically, graphically, numerically in tables, or by verbal descriptions.
- 8.FN.5:** Distinguish between linear and nonlinear functions by comparing graphs and equations.
- 8.FN.6:** Determine the rate of change (slope) and y-intercept (initial value) from tables, graphs, equations, and verbal descriptions of linear relationships.
- 8.FN.7:** Interpret and explain the meaning of the rate of change (slope) and y-intercept (initial value) of a linear relationship in a real-world context.
- 8.FN.8:** Analyze a graph by describing the functional relationships between two quantities.
- 8.FN.9:** Sketch a graph that exhibits qualitative features of a function described verbally.
- 8.ALG.1:** Analyze and solve one-variable linear equations with rational coefficients containing solutions with one, zero, or infinitely many solutions.
- 8.ALG.2:** Analyze and solve one-variable linear inequalities with rational coefficients.
- 8.ALG.3:** Analyze and solve systems of linear equations in the form $y = mx + b$ in real-world or mathematical contexts, graphically and algebraically.
- 8.SP.1:** Construct scatter plots using bivariate data; determine if the data displays a linear or nonlinear pattern and positive, negative, or no association.
- 8.SP.2:** Construct straight lines to approximately fit data displaying a linear association when presented in scatter plots.
- 8.SP.3:** Construct and interpret a relative frequency table, using data from two categorical variables collected from the same subject.

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