Algebra 1 Standards

Algebra 1 (A1) builds essential concepts necessary for students to meet their post-secondary goals (whether they pursue additional study or enter the workforce). This can result in helping students to function as effective citizens, and to recognize the wonder, joy, and beauty of mathematics (NCTM, 2018). Algebra is important and useful in most careers. It is one of the most common and malleable types of mathematics, because it is valuable in a range of activities from ordinary decision making to advanced training in scientific and technological fields. The ability to understand and apply algebraic thinking is a crucial steppingstone on a successful journey in life. Algebra is a collection of unifying concepts that enable one to solve problems flexibly. The standards and indicators in A1 are sorted within the strands of Data, Probability, and Statistical Reasoning (DPSR); Measurement, Geometry, and Spatial Reasoning (MGSR); Numerical Reasoning (NR); and Patterns, Algebra, and Functional Reasoning (PAFR).
The study of algebra is inextricably linked to the study of functions, which are fundamental objects in mathematics that model many life situations involving change. A1 provides experiences for students to see how mathematics can be used systematically to represent patterns and relationships among numbers and other objects, analyze change, and model everyday events and problems of life and society.

A1 emphasizes functions, including linear (as introduced in seventh and eighth grades), absolute value, quadratic, and exponential; and functions as explicit (relation between input and output) and recursive (relation between successive values). Properties of algebra are applied to convert between forms of expressions and to solve equations (factoring, completing the square, rules of powers, and radicals).

Graphing is a vital component of study in A1. Graphs of equations and inequalities consist of all points (discrete or continuous) whose ordered pairs satisfy the relationship within the domain and range. Students find points of intersection between two graphed functions that correspond to the solutions of the equations of the two functions, and transform graphs of functions (through translation, reflection, rotation, and dilation) by performing operations on the input or output.

A1 serves as a study of linear, quadratic, exponential, and absolute value functions. Equations and expressions with linear and quadratic terms are also studied to learn how algebraic expressions model real-world situations. Statistical reasoning is studied to learn how data are represented and interpreted and how models, particularly linear, can be used to make predictions.

Prerequisite course: Geometry with Statistics

Mathematical Process Standards

Standard	Indicator	Indicator Insight
PROBLEM SOLVING	MPS.PS.1 Make sense of problems and persevere in solving them strategically.	Experience problems that are interesting and relevant to students' lives, demonstrating the impact of mathematics. Begin by identifying the meaning of a problem, utilizing appropriate tools, and clearly articulating the "what" of the question. Draw on prior knowledge and analyze given information, including constraints, relationships, and goals, to find entry points or pathways to a solution. Employ critical thinking skills to consider analogous problems, using special cases and simpler forms of the problem to gain additional insight into the solution. Explain similarities and differences between equations and expressions, including their graphical and tabular representations. Draw diagrams and graph data to clarify information, show relationships, and search for patterns and trends.
REPRESENTATION & COMMUNICATION	MPS.RC.1 Explain ideas using precise and contextually appropriate mathematical language, tools, and models.	Engage in discourse to explain reasoning and select tools, both physical and electronic, that are helpful to explore, model, and deepen students' understanding of mathematical concepts. Understand and use definitions and verbal/written information to construct arguments and prove conjectures. By actively listening to the mathematical ideas of other students while communicating their own, they can solve problems collaboratively. Compare two arguments, distinguish and explain the difference between correct and flawed logic, and explain what is flawed or correct and why. Present conclusions and results using a variety of ways, including, but not limited to, tables, graphs, formulas, diagrams, flowcharts, interactive models, and dynamic software. Collaborate with others utilizing joint thinking to solve problems. Utilize technology tools such as graphing utilities, dynamic geometry, spreadsheets, and computer algebra systems.
CONNECTIONS	MPS.C.1 Demonstrate a deep and flexible conceptual understanding of mathematical ideas, operations, and relationships while making real-world connections.	Identify relevant quantities and apply what students know to solve problems related to everyday life situations. Identify important quantities in real-life situations and create a pathway representing relationships, applying appropriate tools, such as diagrams, two-way tables, graphs, flowcharts, and formulas as well as electronic tools such as graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry. Have students confidently apply what they know, making assumptions and approximations to simplify complicated situations. Have students evaluate the reasonableness of their thinking and solution(s) and be willing to make revisions if necessary. Connect and apply the skills and prior knowledge from previous math concepts to solve real-world complex situations.

Standard	Indicator	Indicator Insight
ANALYZE & JUSTIFY	MPS.AJ.1 Use critical thinking skills to reason both abstractly and quantitatively.	Make sense of quantities and their application to relationships in mathematical and real-world representations. Evaluate multiple sources of information from text, charts, tables, graphs, and other diverse media and formats. Have students write explanatory text that conveys their mathematical analyses and thinking. Apply concrete details, relevant facts, and coherent discussions of ideas to support thinking. Decontextualize by pulling information from a given situation, representing it symbolically, then manipulating the representing symbols as if they are their own entities, not necessarily relative to what the symbol stands for. Contextualize by pausing during the manipulation process to explore the meaning of symbols within the given situation.
STRUCTURE & PATTERNS	MPS.SP.1 Identify and apply regularity in repeated reasoning to make generalizations.	Examine, discern, and recognize patterns or structures as complex mathematical objects composed of more than one simple object. Have students attend to detail and continually evaluate the reasonableness of their results. Transform more complex structures into something students know. Discern and recognize regularity in repeated reasoning.

Data, Probability, and Statistical Reasoning

A1.DPSR.1. Use statistical reasoning to summarize, represent, and interpret data on two categorical and quantitative variables.

Indicator #	*Indicator*	*Indicator Insight*
A1.DPSR.1.1	Summarize categorical data in two-way frequency tables, interpret relative frequencies in real-world situations, and informally determine possible associations and trends in the data.	Include joint, marginal, and conditional relative frequencies.
A1.DPSR.1.2	Summarize quantitative data in a table and on a scatterplot and describe how the variables are associated. Limit to linear data.	Description must include: • Direction – positive or negative. • Association – none, weak, moderate, or strong.
A1.DPSR.1.3	Find a linear function for a scatterplot that suggests a linear association.	Include instruction with and without technology to assist with finding the line of best fit for two quantitative variables. Use the given model, or choose a model suggested by the shape of the graph.
A1.DPSR.1.4	For linear associations, use technology to determine the correlation coefficient, evaluate the strength of the association, and find the line of best fit.	Correlation applies to linear models only. Use technology or statistical software to assist in finding linear associations.

A1.DPSR.2. Analyze and interpret models for two categorical and quantitative variables.

Indicator #	*Indicator*	*Indicator Insight*
A1.DPSR.2.1	Use two-way frequency tables to make inferences and interpret the data in terms of real-world or mathematical situations.	Use relative frequencies to identify possible associations.
A1.DPSR.2.2	Interpret the slope and the intercept of a linear model in the context of the data.	Interpret slope as a unit rate of change (including units). For every one unit of increase in the *x* variable, the *y* variable will increase or decrease the amount and the direction of the slope. The *y*-intercept of a linear model may not make sense when interpreted within the context of the data.
A1.DPSR.2.3	Use a linear model to interpolate and extrapolate unknown values close to the data set.	Explore interpolation and extrapolation. Discuss the dangers of extrapolation. Use technology or statistical software.

Measurement, Geometry, and Spatial Reasoning

A1.MGSR.1. Use geometric concepts and measurement opportunities to model mathematical and real-world situations.

Indicator #	*Indicator*	*Indicator Insight*
A1.MGSR.1.1	Identify any limitations specific to a real-world situation.	Produce a graph for a contextual situation and determine a scale that shows key features of the graph. Limitations might include measuring to the nearest cent or dollar or whole unit (such as people or cars) when a fraction does not make sense.

Numerical Reasoning

A1.NR.1. Represent all points on the number line as irrational and rational numbers in the real number system.

Indicator #	*Indicator*	*Indicator Insight*
A1.NR.1.1	Rewrite numerical and algebraic expressions of irrational and rational numbers involving radicals, including addition, subtraction, multiplication, and division. Limit to square and cube roots.	Include all operations with algebraic expressions with emphasis on rational and radical terms.

A1.NR.2. Represent exponents and radical expressions in different ways.

Indicator #	*Indicator*	*Indicator Insight*
A1.NR.2.1	Translate between rational exponents and radical expressions of irrational and rational numbers. Use properties of addition, subtraction, multiplication, and division to simplify radical and rational expressions. Limit to square and cube roots.	Discuss when rational exponents or radical forms may be more useful given the mathematical or real-world context involved.

Patterns, Algebra, and Functional Reasoning

A1.PAFR.1. Transform and/or solve equations and expressions in one variable that model real-world and mathematical situations, interpret the solutions, and determine whether they are reasonable.

Indicator #	*Indicator*	*Indicator Insight*
A1.PAFR.1.1	Transform an equation in one variable to create new equations that have the same solution as the original and justify the steps taken.	Single variable forms may have analogous two-variable forms. Analogous forms include for linear: standard, y-intercept, and point slope, for quadratic: vertex, standard, and factored. For exponential, limit to the same bases.
A1.PAFR.1.2	Solve literal equations and formulas for a specified variable including equations and formulas that arise in a variety of disciplines.	The process of solving literal equations should incorporate similar strategies used in solving for unknown numerical quantities.
A1.PAFR.1.3	Solve mathematical and real-world situations using linear, quadratic, exponential (same bases), and linear absolute value equations in one variable.	The steps used for solving an equation should be identified as a justification for the solution process.
A1.PAFR.1.4	Add, subtract, and multiply polynomials with initial terms up to a degree of 2.	When performing operations with polynomials, relate to the properties of equality.

A1.PAFR.2. Create, solve, and transform equations and inequalities in two or more variables to represent relationships between quantities and graph the equations on coordinate axes using appropriate labels, units, and scales.

Indicator #	*Indicator*	*Indicator Insight*
A1.PAFR.2.1	Transform linear, quadratic, exponential, and linear absolute value functions to equivalent forms to identify slope and *y*-intercept for linear, vertex, and roots (if any) for quadratic and linear absolute value, and *y*-intercept for exponential.	Determine which form of a function is used to identify the information. Fluently transform linear functions into multiple forms. Linear forms include standard, intercept, *y*-intercept, and point-slope. Fluently transform quadratic functions into multiple forms. Quadratic forms include vertex, standard, and factored. Fluently transform exponential functions using growth and decay models. Limit exponential to the same bases.
A1.PAFR.2.2	Solve quadratic equations by completing the square, factoring, and the quadratic formula, explaining the connection between the zeros of the function derived from the equation, its linear factors (if it factors), the *x*-intercepts of its graph (if they exist), and the solutions (if any) to the corresponding quadratic equation.	Completing the square may include a visual model such as algebra tiles. Quadratic equations that result in negative numbers underneath the square root are determined to have no solutions in the real number system.
A1.PAFR.2.3	Solve and graph linear, quadratic, exponential, and linear absolute value equations given in tabular, symbolic, and/or verbal forms using intercepts, domain and range, intervals of increasing and decreasing, vertex (maximum and minimum), end-behavior, and symmetry, and interpret these in terms of mathematical and real-world situations.	Tabular form should involve a spreadsheet.
A1.PAFR.2.4	Create, solve, and graph linear inequalities in two variables.	Inequalities are used to solve contextual problems.
A1.PAFR.2.5	Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.	Use contextual situations and sets of ordered pairs to create functions to describe relationships.

Indicator #	*Indicator*	*Indicator Insight*
A1.PAFR.2.6	Create symbolic representations of linear and exponential functions, including arithmetic and geometric sequences, given graphs, verbal descriptions, and tables.	When given an addition/subtraction pattern or a multiplication/division sequence, generalize an arithmetic or geometric sequence; create both explicit and recursive functions for the pattern. Connect linear functions and arithmetic sequences. Connect exponential functions and geometric sequences.
A1.PAFR.2.7	Use graphs to obtain exact and/or approximate solutions of equations, inequalities, and systems of linear equations in two variables (given or obtained by using technology).	A possible strategy to use successive approximations as a method to solve the system $y = f(x)$ and $y = g(x)$ to find approximate solutions with graphs and tables.
A1.PAFR.2.8	Solve an equation of the form $f(x) = g(x)$ graphically by identifying the x-coordinate(s) of the point(s) of intersection of the graphs of $y = f(x)$ and $y = g(x)$.	The *x*-coordinate(s) of the point(s) where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solution(s) of the equation $f(x) = g(x)$.
A1.PAFR.2.9	Solve systems of linear equations algebraically and graphically.	Solving algebraically means using linear combinations (elimination) and substitution. Teachers are encouraged to teach solving equations collectively, not in isolation.
A1.PAFR.2.10	Analyze the growth/decay rate between linear and exponential functions specifically between consecutive integers.	Demonstrate that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals. Use graphs and tables to recognize that a quantity increasing exponentially eventually exceeds a quantity increasing linearly.

A1.PAFR.3. Represent and interpret functions symbolically and graphically.

Indicator #	*Indicator*	*Indicator Insight*
A1.PAFR.3.1	Recognize that $f(x)$ denotes the output of function f that corresponds to the input x, and this corresponds to the set of all the ordered pairs (*x, y*) that satisfy the equation *y = f(x)* both tabularly and graphically.	Function notation reveals both the input and output in a single statement. Connect the statements "the graph of ***f***" and "the graph of *y = f(x).*"
A1.PAFR.3.2	Use the definition of a function to analyze the domain and range of a function in relation to its graph, mapping, table, verbal, and/or symbolic description and, where applicable, using interval and set notation.	Tabular representation may be done using a spreadsheet.

Indicator #	*Indicator*	*Indicator Insight*
A1.PAFR.3.3	Translate among graphical, tabular, verbal, and symbolic representations in function notation, to identify intercepts, intervals where the function is increasing, decreasing, constant, maximums and minimums, and symmetries and explain their meanings in real-world and mathematical situations.	A computer algebra system may be used for translating among the different representations.
A1.PAFR.3.4	Interpret how lead coefficients impact the shape of a function's graph.	Relate the value of the coefficients to geometric transformations.

A1.PAFR.4. Reason with parent functions in varying representations to find families of functions that all have similar distinguishing attributes common to the family and use common characteristics to aid in rewriting and identifying linear, linear absolute value, quadratic, and exponential functions.

Indicator #	*Indicator*	*Indicator Insight*
A1.PAFR.4.1	Describe the effect of the transformations $kf(x)$, $f(x)+k$, $f(x-k)$, and combinations of such transformations on the graph of parent function $y = f(x)$ for any real number k; find the value of k given the graphs; and write the equation of a transformed parent function given its graph.	Use technology with a parent function to explore the results when different transformations are applied – translations, reflections, and dilations.
A1.PAFR.4.2	Given a real-world or mathematical situation, determine the parent graph that best models the situation.	Consider rates of change, graphs, context, or a table of values to determine the parent function.
A1.PAFR.4.3	Given different representations of two different functions, compare key features including intercepts, domain and range, intervals of increasing and decreasing, constant, average rate of change, and maximum and minimum values.	Flexibly use different representations of functions (graphs, tables, verbal, and symbols) to compare key features of the functions.