

# MATHEMATICS

## GRADES 9-12

**Theory of Action:** Academic standards represent a collective commitment around what students should learn each year. The state assessment asks students to demonstrate their knowledge, skills, and understanding related to these standards using a common measure. The resulting data allows us to see patterns in performance that should guide school and district improvement, helping identify areas of strength and opportunity.

**Role of PLDs in Defining Proficiency:** Performance level descriptors bridge the state assessment to classroom instruction and the systems of formative assessments that guide local instruction and choices about individual students. *Academic proficiency represents a range of observable student performance characteristics.* There are multiple pathways to proficiency, and students rely upon their strengths differently within that range of performance.

**Proficiency and Difficulty:** A student's ability to demonstrate proficiency is influenced by the complexity of the texts or stimuli presented, tasks they're asked to complete, and the contexts in which they are engaged. As student performance improves, students are typically able to handle more challenging texts/stimuli, tasks, and contexts, and are able to demonstrate their skills and knowledge more accurately and consistently.

### Claim 1: Functions<sup>i</sup> *Student performance indicates the ability to ...*

<b>Above Proficient</b>	Demonstrate a strong understanding of functions, including logarithmic, rational, radical, and trigonometric functions, and their transformations, compositions, and inverses. Can analyze and model linear, exponential, and trigonometric behaviors, including their graphs and key features.
<b>Proficient</b>	Demonstrate a solid grasp of linear, quadratic, and exponential functions, including their transformations, domain/range, and key features; graph and analyze these functions, including polynomial functions, and manipulate them through operations, such as multiplication and division; and perform operations involving trigonometric functions, right triangle trigonometry, and special right triangles.
<b>Approaching Proficient</b>	Interpret and analyze linear functions; understand the slope, intercepts, and basic characteristics of linear functions; use function notation; identify the effects of transformations on graphs; and find inverses.
<b>Below Proficient</b>	Demonstrate a foundational understanding of functions, working with tables, ordered pairs, and basic linear graphs; identify changes to basic functions and recognize key features of linear and exponential models, including growth/decay from graphs; and use the Pythagorean theorem.

### Claim 2: Numbers and Quantity<sup>ii</sup> *Student performance indicates the ability to ...*

<b>Above Proficient</b>	Recognize and apply rational exponents in various contexts and solve multi-step equations involving them; utilize properties of rational and irrational numbers in practical applications like area and volume; and solve problems with complex numbers, demonstrating the ability to find complex solutions to polynomial equations through multiple steps.
<b>Proficient</b>	Perform operations with rational exponents, simplify expressions, and compute exponential expressions; justify the properties of rational and irrational numbers, including how their sums and products result in rational or irrational values; simplify algebraic expressions with complex numbers; perform calculations involving complex numbers (product, quotient, powers of $i$ ); and solve quadratic equations to find complex zeros using factoring or the quadratic formula.
<b>Approaching Proficient</b>	Convert between roots and rational exponents; perform addition and multiplication with both rational and irrational numbers; calculate sums and differences with complex numbers, including rewriting negative radicands as complex numbers; and determine the number of complex solutions of a polynomial based on its graph.
<b>Below Proficient</b>	Apply properties of integer exponents to simplify and identify equivalent expressions; compute basic exponential expressions and classify numbers as either rational or irrational, approximating the placement of irrational numbers on the real number line; identify the real and imaginary components of complex numbers; and find solutions (zeros) to quadratic equations with real solutions using either factoring or the quadratic formula.

**Claim 3: Algebra<sup>iii</sup>** *Student performance indicates the ability to ...*

<b>Above Proficient</b>	Model real-world situations using quadratic, rational, or exponential equations and inequalities, solve problems and graphing models; factor and solve quadratics, manipulate rational expressions, and employ the Remainder Theorem; solve systems of equations using various methods, such as matrices, and graph solution sets for linear inequalities, illustrating their understanding of the relationships between equations and their graphical representations.
<b>Proficient</b>	Model and solve linear situations using equations and inequalities, graphing those models and assessing the viability of their solutions; interpret and manipulate quadratic expressions, factoring special cases and identifying key features such as vertex, maximum or minimum values, and axes of symmetry; perform operations on polynomials, recognize polynomial identities, and utilize the Binomial Theorem; solve rational and radical equations, including understanding extraneous solutions, and solve systems of equations involving linear and quadratic functions; effectively analyze and graph solution sets for linear inequalities.
<b>Approaching Proficient</b>	Evaluate and graph linear and quadratic models, solving systems of equations and inequalities graphically; manipulate linear and quadratic expressions, factoring them and identifying key features like intercepts and vertex; use exponent properties, work with geometric series, and perform operations on polynomials; solve equations and inequalities, including rational and radical equations, using properties of equality, and graph linear inequalities in two variables.
<b>Below Proficient</b>	Verify solutions to equations and inequalities, apply formulas with given inputs, and substitute values into expressions; identify parts of linear expressions and perform basic factoring (GCF); partially identify the vertex and concavity of a quadratic function; perform operations on monomials and polynomials; solve one and two-step linear equations and inequalities, identify solutions to systems of equations graphically, and graph single-variable inequalities on a number line.

**Claim 4: Statistics and Probability<sup>iv</sup>** *Student performance indicates the ability to ...*

<b>Above Proficient</b>	Analyze real-world data to draw conclusions, comparing data sets, interpreting z-scores, and extrapolating trends; select appropriate models, determine the line of best fit, and perform linear regressions; utilize randomized processes and simulation models for inference and evaluate data-based reports; apply concepts of conditional probability, independence, and compound probability; define random variables, create probability distributions, and calculate expected values, applying these concepts to real-world scenarios like games of chance and insurance policies; and use probabilities to make fair decisions and analyze strategies.
<b>Proficient</b>	Analyze data using box plots, histograms, and describe the data's shape; choose appropriate measures for center (median/mean) and spread (IQR/std dev) based on the data's shape and determine when to include or exclude outliers; estimate areas under normal curves, complete two-way frequency tables, and model scatterplots with quadratic or exponential equations; interpret the slope and y-intercept of linear regression models; justify the use of a linear regression model using the correlation coefficient; evaluate randomized samples and justify if a model is consistent with a data-generated process; describe the different study types; calculate the probability of independent and conditional events, as well as compound events using the addition, multiplication rules, permutations, and combinations; and graph probability distributions.
<b>Approaching Proficient</b>	Calculate descriptive statistics (mean, median, mode), interpreting data shapes to choose appropriate measures of center, and identifying outliers in box plots; calculate z-scores, create linear models, and interpret the results of those models; identify different study types, two-way frequency tables, and conditional probability; and analyze probability distributions from graphs.
<b>Below Proficient</b>	Organize data and identify characteristics, such as modes and outliers within data sets; evaluate the suitability of a normal distribution for a given dataset and determine correlations in scatter plots; recognize the significance of surveys and observational studies in statistics; and describe the sample space for random variables, such as outcomes from multiple coin flips.

**Claim 5: Geometry<sup>v</sup>** *Student performance indicates the ability to ...*

<b>Above Proficient</b>	Explain geometric transformations, including rotations, reflections, and the application of congruence criteria; utilize geometric principles to solve problems, calculate areas of composite shapes, and prove theorems about triangles; calculate volume of three-dimensional objects; and solve problems involving these concepts.
<b>Proficient</b>	Use geometry skills, including recognizing and performing basic transformations, identifying congruent and similar figures, and applying triangle congruence criteria to solve problems; utilize angle relationships, distinguish among properties of geometric shapes, and construct basic geometric figures; use trigonometric ratios, circle properties (including equations and area/circumference), and basic coordinate geometry concepts like slope and finding perimeters/areas; and classify geometric shapes and figures.
<b>Approaching Proficient</b>	Recognize and perform basic transformations, identify congruent and similar figures, and apply triangle congruence criteria; utilize angle relationships, distinguish among properties of geometric shapes, and construct basic geometric figures; understand trigonometric ratios, circle properties (including equations and area/circumference), and basic coordinate geometry concepts like slope and finding perimeters/areas; and classify geometric shapes and figures.
<b>Below Proficient</b>	Define basic geometric terms and identify congruent shapes; perform and verify properties of rigid transformations, recognize angle relationships, and apply triangle and parallelogram properties; apply the Pythagorean theorem; identify circle parts; calculate area and circumference; work with coordinates; and determine volumes of basic 3D shapes.

<sup>i</sup> Includes standards IF.1, IF.2, IF.3, IF.4, IF.5, IF.6, IF.7, IF.8, IF.9, BF.1, BF.2, BF.3, BF.4, BF.5, LE.1, LE.2, LE.3, LE.4, LE.5

<sup>ii</sup> Includes standards RN.1, RN.2, RN.3, CN.1, CN.2, CN.7

<sup>iii</sup> Includes standards A.CED.1, A.CED.2-3, A.CED.4, A.SSE.1, A.SSE.1a, A.SSE.1b, A.SSE.2, A.SSE.3, A.SSE.3a, A.SSE.3b, A.SSE.3c, A.SSE.4, A.APR.1, A.APR.2, A.APR.3, A.APR.4, A.APR.6, A.REI.1, A.REI.2, A.REI.3, A.REI.4, A.REI.4a, A.REI.4b, A.REI.5, A.REI.6, A.REI.7, A.REI.10, A.REI.11, A.REI.12

<sup>iv</sup> Includes standards ID.1, ID.2, ID.3, ID.4, ID.5, ID.6, ID.7, ID.8, ID.9, IC.1, IC.2, IC.3, IC.4, IC.5, IC.6

<sup>v</sup> Includes standards CO.1, CO.2, CO.3, CO.4, CO.5, CO.6, CO.7, CO.8, CO.9, CO.10, CO.11, CO.12, CO.13, SRT.1, SRT.2, SRT.3, SRT.4, SRT.5, SRT.6, SRT.7, SRT.8, G-C.1, G-C.2, G-C.3, G-C.5, G-GPE.1, G-GPE.2, G-GPE.4, G-GPE.5, G-GPE.6, G-GPE.7, G-GMD.1, G-GMD.3, G-GMD.4, G-MG.1, G-MG.2, G-MG.3