Grades 9–12: Algebra

Hand-held graphing calculators are required as part of instruction and assessment. Students should use a variety of representations (concrete, numerical, algorithmic, graphical), tools (matrices, data), and technology to model mathematical situations in solving meaningful problems. Technology includes, but is not limited to, powerful and accessible hand-held calculators as well as computers with graphing capabilities.

STANDARD I. Understand patterns, relations, and functions.

EXPECTATION A. Generalize patterns using explicitly defined and recursively defined functions.

*1. Interpret and make inferences from explicit and recursive functional relationships.
*2. Describe independent and dependent quantities in functional relationships.
*3. Use patterns to generate the laws of exponents and apply them in problem-solving situations.

EXPECTATION B. Understand relations and functions and select, convert flexibly among, and use various representations for them.

*1. Gather and record data, or use data sets, to determine functional (systematic) relationships between quantities.
*2. Represent relationships among quantities using concrete models, tables, graphs, diagrams, verbal descriptions, equations, and inequalities including representations involving computer algebra systems, spreadsheets, and graphing calculators.
*3. Interpret situations in terms of given graphs and create situations that fit given graphs.

EXPECTATION **C. Analyze functions of one variable by investigating rates of change, intercepts, zeros, asymptotes, and local and global behavior.**

*1. Relate the solution(s) of quadratic equations to the root(s) of the quadratic functions.
*2. Determine domain and range restrictions for linear and quadratic functions, given the constraints of the problem.
*3. Analyze graphs of quadratic functions and write conclusions for problem situations.

EXPECTATION **D. Understand and perform transformations such as arithmetically combining, composing, and inverting commonly used functions, using technology to perform such operations on more complicated symbolic expressions.**

EXPECTATION **E. Understand and compare the properties of classes of functions, including exponential, polynomial, rational, logarithmic, and periodic functions.**

*1. Identify and sketch the general forms of linear ($y = x$) and quadratic ($y = x^2$) parent functions.
*2. Determine reasonable domain and range values for a variety of situations.
*3. Relate direct variation to linear functions and solve problems involving proportional change.
*4. With and without using a graphing calculator, investigate, describe, and predict the effects of changing the slope and the *y*-intercept in applied situations.
*5. With and without using a graphing calculator, investigate, describe, and predict the effects of vertical and horizontal translations, reflections, and dilations on linear and quadratic functions.
6. With and without using a graphing calculator, investigate, describe, and predict the effects of vertical and horizontal translations, reflections, and dilations on exponential, polynomial, rational, logarithmic, and periodic functions.

EXPECTATION **F. Interpret representations of functions of two variables.**

1. Recognize that real-world phenomena can be modeled by specific functions (e.g., population growth can be modeled by exponential functions, periodicity can be modeled by trigonometric functions).

STANDARD II. Represent and analyze mathematical situations and structures using algebraic symbols.

EXPECTATION **A. Understand the meaning of equivalent forms of expressions, equations, inequalities, and relations.**

*1. Find specific function values and evaluate expressions.
*2. Simplify polynomial expressions and perform polynomial arithmetic.
3. Represent functions in algebraic, tabular, graphical, and verbal forms using paper and pencil, graphing calculators, computer algebra, and spreadsheet technologies.

EXPECTATION **B. Write equivalent forms of equations, inequalities, and systems of equations and solve them with fluency—mentally or with paper and pencil in simple cases and using technology in all cases.**

*1. Transform and solve equations and inequalities, factoring as necessary in problem situations.
*2. Solve systems of linear equations using concrete models, graphs, tables, and algebraic methods.
*3. Select a method for solving linear equations and inequalities and then solve the equations and inequalities.
*4. Solve quadratic equations using concrete models, tables, graphs, and algebraic methods that include factoring, the quadratic formula, and computer algebra systems, spreadsheets, and graphing calculators.

EXPECTATION **C. Use symbolic algebra to represent and explain mathematical relationships**.

*1. Look for patterns and represent generalizations algebraically in given situations.
*2. Use symbols to represent unknowns and variables.

EXPECTATION **D. Use a variety of symbolic representations, including recursive and parametric equations, for functions and relations.**

*1. Translate among and use algebraic, tabular, graphical, or verbal descriptions of linear functions using computer algebra systems, spreadsheets, and graphing calculators.
2. Translate among and use algebraic, tabular, graphical, or verbal descriptions of quadratic, rational, exponential and other functions using computer algebra systems, spreadsheets, and graphing calculators.
3. Translate among and use algebraic, tabular, graphical, or verbal descriptions of recursive and parametric equations or functions, using computer algebra systems, spreadsheets, and graphing calculators.

EXPECTATION **E. Judge the meaning, utility, and reasonableness of the results of symbol manipulations, including those carried out by technology.**

*1. Interpret solutions and determine the reasonableness of solutions to linear equations and inequalities.
*2. Interpret solutions and determine the reasonableness of solutions to systems of linear equations.

STANDARD III. Use mathematical models to represent and understand quantitative relationships.

EXPECTATION A. Identify essential quantitative relationships in a situation and determine the class or classes of functions that might model the relationships.

*1. Determine whether or not given situations can be represented by linear functions.
*2. Analyze situations involving linear functions and formulate linear equations or inequalities to solve problems.
3. Determine whether or not given situations can be represented by nonlinear functions.
4. Analyze situations involving nonlinear functions and formulate nonlinear equations or inequalities to solve problems.

EXPECTATION B. Use symbolic expressions, including iterative and recursive forms, to represent relationships arising from various contexts.

*1. Describe functional relationships for given problem situations and write equations, inequalities, and recursive relations to answer questions arising from the situations.
*2. Graph and write equations of lines given characteristics such as two points, a point and a slope, or a slope and y-intercept.
3. Analyze data and represent situations involving inverse variation using concrete models, tables, graphs, or algebraic methods as well as computer algebra systems, spreadsheets, and graphing calculators.
4. Analyze data and represent situations involving exponential growth and decay using concrete models, tables, graphs, or algebraic methods as well as computer algebra systems, spreadsheets, and graphing calculators.

EXPECTATION C. Draw reasonable conclusions about a situation being modeled.

1. Verify and explain the conclusion based on the data and the processes used.
2. Demonstrate that no solution or multiple solutions may exist.

STANDARD **IV. Analyze change in various contexts.**

EXPECTATION **A. Approximate and interpret rates of change from graphical and numerical data.**

1. Interpret rates of change as they apply to phenomena such as inflation, spread of disease, population growth, tax brackets, and pollution.
2. Analyze graphical data gathered by technical equipment including combinations of graphs, periodic phenomena, and rates of change.
3. Determine changes in slope relative to the changes in the independent variable.