

# Grades 9, 10, 11, 12

Adopted 2023

## Algebra I

### Expressions

Polynomials, Roots, & Exponent Laws

**EX.** 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. [A1.EX.1](#)
2. Simplify and perform operations with radical expressions without variables; rationalizing denominators should not include conjugates. [A1.EX.2](#)
3. Simplify algebraic expressions using the laws of exponents. [A1.EX.3](#)
4. Interpret the parts of expressions such as terms, factors, and coefficients in terms of a real-world context. [A1.EX.4](#)

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## Functions

### Domain & Range, Function Notation

- FN1.** Students understand the concept of a function, domain and range, and use function notation; students use function notation to solve problems. **A1.FN1**
1. Explain that a function assigns each element in the domain to exactly one element in the range. **A1.FN.1**
  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  $x$ . **A1.FN.2**
  3. Graph functions given in function notation, understanding that the graph contains the points  $(x, f(x))$ . **A1.FN.3**
  4. Evaluate functions expressed in function notation for one or more elements in their domains (inputs); use function notation to describe a contextual situation. **A1.FN.4**

### Construct & Compare

- FN2.** Students construct and compare linear, quadratic, and exponential models and solve problems. **A1.FN2**
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. **A1.FN.5**
  6. Compare the growth pattern of exponential to linear or quadratic functions using graphs and tables and recognize how exponential growth exceeds other functions. **A1.FN.6**

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## Linear Functions, Equations, & Inequalities

### Create & Solve

**LFE1.** Students create and solve equations that model linear relationships. **A1.LFE1**

1. Represent and solve real-world problems, using linear expressions, equations, and inequalities in one variable. **A1.LFE.1**
2. Construct linear functions from arithmetic sequences with and without context. **A1.LFE.2**
3. Solve linear formulas for a specified variable. **A1.LFE.3**
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. **A1.LFE.4**

### Interpret Key Features

**LFE2.** Students interpret key features of equations that model linear relationships. **A1.LFE2**

5. Determine the domain and range of linear functions in mathematical problems. **A1.LFE.5**
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. **A1.LFE.6**
7. Interpret the key features of a linear and absolute value functions that models a relationship between two quantities in a given context. **A1.LFE.7**
8. Flexibly use different representations of a linear function, including graphs, tables, and equations. **A1.LFE.8**
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. **A1.LFE.9**
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. **A1.LFE.10**

### Systems of Equations & Inequalities

**LFE3.** Students solve systems of equations and inequalities. **A1.LFE3**

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. **A1.LFE.11**
12. Solve a system of equations consisting of a linear equation and a quadratic equation in two variables graphically with the assistance of technology. **A1.LFE.12**

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. [A1.LFE.13](#)
14. Solve linear inequalities and systems of linear inequalities in two variables by graphing. [A1.LFE.14](#)

#### Graphing & Transformations

**LFE4.** Students graph linear functions, equations, and inequalities. [A1.LFE4](#)

15. Write linear equations that model the relationship between two quantities and produce a graph of the equation. [A1.LFE.15](#)
16. Graph linear functions expressed as an equation and show intercepts of the graph without technology. [A1.LFE.16](#)
17. Graph absolute value functions expressed as an equation with and without technology, showing intercepts and end behavior. [A1.LFE.17](#)
18. Graph and generalize the effect of transformations on linear and absolute value functions.
  - Transformations include: stretches, compressions, vertical, and horizontal[A1.LFE.18](#)
19. Given the graph of a linear function, explain the effects of the transformation from the parent function,  $y=x$ . [A1.LFE.19](#)

#### Statistical Relationships

**LFE5.** Students explore linear statistical relationships. [A1.LFE5](#)

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. [A1.LFE.20](#)
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. [A1.LFE.21](#)
22. Compare and contrast correlation and causation in real-world problems. [A1.LFE.22](#)

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## Quadratic Functions & Equations

### Create & Solve

**QFE1.** Students create and solve equations that model quadratic relationships. [A1.QFE1](#)

1. Represent and solve real-world problems using quadratic expressions and equations in one variable. [A1.QFE.1](#)
2. Write quadratic equations with real number solutions that model the relationship between two quantities and produce a graph of the equation. [A1.QFE.2](#)
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.[A1.QFE.3](#)

### Interpret Key Features

**QFE2.** Students interpret key features of equations that model quadratic relationships. [A1.QFE2](#)

4. Determine the domain and range of quadratic functions in mathematical problems. [A1.QFE.4](#)
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. [A1.QFE.5](#)
6. Interpret the key features of a quadratic function that models a relationship between two quantities in a given context. [A1.QFE.6](#)
7. Flexibly use different representations of a quadratic function, including graphs, tables, and equations. [A1.QFE.7](#)
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. [A1.QFE.8](#)
9. Use factoring and completing the square to create equivalent forms of quadratic functions to reveal key attributes. [A1.QFE.9](#)

### Graphing & Transformations

**QFE3.** Students graph quadratic functions and explore different transformations of  $f(x) = x^2$ . [A1.QFE3](#)

10. Graph quadratic functions given as an equation or in function notation, labeling key attributes, without technology. [A1.QFE.10](#)
11. Graph and describe the effect of transformations on quadratic functions.
  - Transformations include: stretches, compressions, vertical, and horizontal[A1.QFE.11](#)

12. Given the graph of a quadratic function, explain the effects of the transformation from the parent function,  $y = x^2$ . [A1.QFE.12](#)

#### Statistical Relationships

**QFE4.** Students explore quadratic statistical relationships. [A1.QFE4](#)

13. Write quadratic functions that provide a reasonable fit to data and use them to make predictions with technology. [A1.QFE.13](#)

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### Exponential Functions & Equations

#### Create & Solve

**EFE1.** Students create and solve problems that model exponential relationships. [A1.EFE1](#)

1. Represent and solve real-world problems, using exponential equations in one variable. [A1.EFE.1](#)
2. Represent real-world problems (growth, decay, and compound interest), using exponential equations. [A1.EFE.2](#)
3. Construct exponential equations from geometric sequences with and without context. [A1.EFE.3](#)

#### Interpret Key Features

**EFE2.** Students interpret key features of equations that model exponential relationships. [A1.EFE2](#)

4. Determine the domain and range of exponential functions in mathematical problems. [A1.EFE.4](#)
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. [A1.EFE.5](#)
6. Interpret the key features of an exponential function that models a relationship between two quantities in a given context. [A1.EFE.6](#)
7. Flexibly use different representations of an exponential function, including graphs, tables, and equations. [A1.EFE.7](#)
8. Interpret the quantities in an exponential equation in the context of a real-world problem, including growth, decay, and compound interest. [A1.EFE.8](#)

#### Graphing

**EFE3.** Students graph exponential functions. [A1.EFE3](#)

9. Graph exponential functions that model real-world problems (growth, decay, and compound interest), showing key attributes. [A1.EFE.9](#)

#### Statistical Relationships

**EFE4.** Students explore exponential statistical relationships. [A1.EFE4](#)

10. Write exponential functions that provide a reasonable fit to data and use them to make predictions with technology. [A1.EFE.10](#)

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## Statistics & Probability

### Numerical Data

**SP1.** Students summarize and describe distributions. [A1.SP1](#)

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. [A1.SP.1](#)
2. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points. [A1.SP.2](#)

### Bivariate Data

**SP2.** Students will investigate patterns of association in bivariate data. [A1.SP2](#)

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. [A1.SP.3](#)
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## Geometry

### Right Triangles

#### Special Right Triangles & Pythagorean Theorem

**RT1.** Students explore right triangles and apply the Pythagorean Theorem. [G.RT1](#)

1. Apply the properties of special right triangles ( $30^\circ$ - $60^\circ$ - $90^\circ$  and  $45^\circ$ - $45^\circ$ - $90^\circ$ ) to solve real-world and mathematical problems. [G.RT.1](#)
2. Prove and apply the Pythagorean Theorem and its converse. [G.RT.2](#)

#### Trigonometry Ratios

**RT2.** Students apply trigonometric ratios to solve problems. [G.RT2](#)

3. Explain how the definitions for trigonometric ratios are developed by similarity and how the side ratios in right triangles are properties of the angles in the triangle. [G.RT.3](#)
4. Explain the relationship between the sine and cosine of complementary angles and use them to solve problems. [G.RT.4](#)
5. Determine the sine, cosine, and tangent ratios of acute angles given the side lengths of right triangles. [G.RT.5](#)
6. Use trigonometric ratios (sine, cosine, and tangent) to calculate missing side lengths and angle measures in a right triangle, including applications of angles of elevation and depression; include real-world and mathematical problems. [G.RT.6](#)

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## Circles

### Circle Relationships

**CIR1.** Students explore and use circle relationships to solve problems. **G.CIR1**

1. Apply the precise definition and standard geometric notation for a circle to understand geometric relationships. **G.CIR.1**
2. Recognize and apply relationships between angles, radii, and chords, tangents, and secants including:
  - The relationship between central, inscribed, and circumscribed angles,
  - Inscribed angles on a diameter are right angles,
  - The radius of a circle is perpendicular to the tangent where the radius intersects the circle, and
  - The relationship of angles and segments formed by chords, secants and/or tangents to a circle.**G.CIR.2**
3. Use the proportional relationship between the measure of an arc length of a circle and the circumference of the circle to solve problems. **G.CIR.3**
4. Use the proportional relationship between the measure of the area of a sector of a circle and the area of the circle to solve problems. **G.CIR.4**
5. Explain why the formulas for the area and circumference of a circle work using dissection and informal limit arguments. **G.CIR.5**

### Equation of a Circle

**CIR2.** Students solve problems involving the equation of a circle. **G.CIR2**

6. Write the equation of a circle, given the radius and center, where the center is at the origin or another point. **G.CIR.6**
7. Identify the center and radius of a circle, given the equation of a circle, where the center is at the origin or another point. **G.CIR.7**
8. Apply the equation of a circle to solve real-world problems. **G.CIR.8**

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## Geometric Figures

### Three-Dimensional

**GF1.** Students explore and solve problems involving three-dimensional figures. [G.GF.1](#)

1. Find the volume and surface area of complex three-dimensional figures composed of prisms, pyramids, cones, cylinders, and spheres. [G.GF.1](#)
2. Use three-dimensional geometric figures and their measures to model real-world objects and solve problems. [G.GF.2](#)
3. Explain why the formulas for the volume and surface area of a cylinder, pyramid, and cone work. [G.GF.3](#)
4. Apply the Pythagorean Theorem to determine missing measurements in a three-dimensional figure. [G.GF.4](#)
5. Identify the three-dimensional figure generated by rotating a two-dimensional figure. [G.GF.5](#)

### Two-Dimensional

**GF2.** Students explore and solve problems involving two-dimensional figures. [G.GF.2](#)

6. Apply theorems about quadrilaterals, including those involving angles, diagonals, and sides to solve problems. [G.GF.6](#)
7. Prove that a given quadrilateral is a parallelogram, rhombus, rectangle, square, kite, or trapezoid, and apply these relationships to solve problems. [G.GF.7](#)
8. Prove and apply theorems about triangles including:
  - Angle-Sum Theorem,
  - Exterior Angle Theorem,
  - Isosceles Triangle Theorem and its converse,
  - Midsegment Theorem,
  - Proportionality Theorem,
  - Inequality Theorem and its converse,
  - and Geometric Mean Theorem.[G.GF.8](#)
9. Calculate the perimeter of polygons when given the vertices, including using the distance formula. [G.GF.9](#)
10. Calculate the area of triangles and rectangles when given the vertices, including using the distance formula and decomposing figures. [G.GF.10](#)
11. Describe reflectional and rotational symmetry as they apply to a rectangle, parallelogram, trapezoid, or regular polygon. [G.GF.11](#)

### Geometric Probability

**GF3.** Students determine probability in geometric contexts. [G.GF.3](#)

12. Calculate probabilities as a proportion of area in a geometric context. [G.GF.12](#)

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## Lines & Angles

### Define & Construct

**LA1.** Students use precise definitions and various construction tools to create geometric figures. **G.LA1**

1. Use precise definitions and standard geometric notation for angles, perpendicular lines, parallel lines, and line segments based on the undefined notions of point, line, and distance along a line. **G.LA.1**
2. Make formal geometric constructions with a variety of tools and methods including:
  - Congruent segments and angles,
  - Segment and angle bisectors,
  - Perpendicular lines and perpendicular bisectors of a line segment,
  - Parallel lines, and
  - An equilateral triangle, a square, and a regular hexagon inscribed in a circle.**G.LA.2**

### Coordinate Geometry

**LA2.** Students reason about geometric figures using the coordinate plane. **G.LA2**

3. Determine the point that cuts a line segment into a specified ratio on a number line and a coordinate plane, including finding the midpoint. **G.LA.3**
4. Derive the distance and midpoint formulas and use the formulas, including the slope formula, to verify geometric relationships on a coordinate plane. **G.LA.4**

### Parallel & Perpendicular Lines

**LA3.** Students solve problems involving parallel and perpendicular lines. **G.LA3**

5. Prove and apply slope criteria of parallel and perpendicular lines to solve problems. **G.LA.5**
6. Write an equation of a line that is parallel or perpendicular to a given line and passing through a given point. **G.LA.6**
7. Prove and apply theorems about lines and angles including:
  - Vertical angles,
  - Angles formed by parallel lines cut by a transversal, and
  - Points on a perpendicular bisector.**G.LA.7**

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## Transformations

### Coordinate Plane

**TRF1.** Students transform figures on the coordinate plane. **G.TRF1**

1. Describe rotations, reflections, and translations as functions that take points in the coordinate plane as inputs and give other points as outputs; write in prime notation. **G.TRF.1**
2. Compare transformations that preserve distance and angle (rotations, reflections, and translations) to those that do not (dilations) to develop definitions for congruence and similarity. **G.TRF.2**

### Plane

**TRF2.** Students transform figures and make geometric constructions. **G.TRF2**

3. Apply understanding of angles, circles, perpendicular lines, parallel lines, and line segments to develop definitions for rotations, reflections, and translations. **G.TRF.3**
4. Use geometric constructions to represent rotations, reflections, translations, and dilations in the plane with a variety of tools and methods. **G.TRF.4**
5. Given two congruent figures, identify the sequence of transformations that maps one figure to another. **G.TRF.5**

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## Similarities & Congruence

### Similarity

**SC1.** Students use similarity criteria to solve problems. **G.SC1**

1. Given two figures, apply the definition of similarity in terms of a dilation to identify similar figures, proportional sides, and corresponding congruent angles. **G.SC.1**
2. Develop and apply the criteria of similarity for triangles (AA~, SAS~, and SSS~) to solve problems and prove geometric relationships. **G.SC.2**
3. Use transformations to prove all circles are similar. **G.SC.3**

### Triangle Congruence

**SC2.** Students apply congruence criteria to solve problems. **G.SC2**

4. Explain, using rigid motion transformations, why two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent. **G.SC.4**
5. Develop and apply the criteria for triangle congruence (ASA, SAS, AAS, SSS, and HL) to solve problems and prove geometric relationships. **G.SC.5**