Ohio Tutorials are designed specifically for the Ohio Learning Standards to prepare students for the Ohio State Tests and end-of-course exams.

Math Tutorials offer targeted instruction, practice and review designed to develop computational fluency, deepen conceptual understanding, and apply mathematical practices. They automatically identify and address learning gaps down to elementary-level content, using adaptive remediation to bring students to grade-level no matter where they start. Students engage with the content in an interactive, feedback-rich environment as they progress through standards-aligned modules. By constantly honing the ability to apply their knowledge in abstract and real world scenarios, students build the depth of knowledge and higher order skills required to demonstrate their mastery when put to the test.

In each module, the Learn It and Try It make complex ideas accessible to students through focused content, modeled logic and process, multi-modal representations, and personalized feedback as students reason through increasingly challenging problems. The Review It offers a high impact summary of key concepts and relates those concepts to students' lives. The Test It assesses students' mastery of the module's concepts, providing granular performance data to students and teachers after each attempt. To help students focus on the content most relevant to them, unit-level pretests and posttests can quickly identify where students are strong and where they're still learning.

Unit 1: Expressions and Equations

- **FORMULATING AND SIMPLIFYING ALGEBRAIC EXPRESSIONS**
  - OH.Math.HSA.SSE.1a: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients.
  - OH.Math.HSA.SSE.1b: Interpret expressions that represent a quantity in terms of its context. Interpret complicated expressions by viewing one or more of their parts as a single entity.
  - OH.Math.HSA.SSE.2: Use the structure of an expression to identify ways to rewrite it.
  - OH.Math.HSA.APR.1b: Understand that polynomials form a system analogous to the integers, namely, that they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. Extend to polynomial expressions beyond those expressions that simplify to forms that are linear or quadratic.
- **LITERAL EQUATIONS**
  - OH.Math.HSA.CED.4: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
  - OH.Math.HSA.REI.3: Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

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- OH.Math.HSA.CED.1a: Create equations and inequalities in one variable and use them to solve problems. Focus on applying linear and simple exponential expressions.
- OH.Math.HSA.CED.4b: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. Focus on formulas in which the variable of interest is linear.
- OH.Math.HSA.CED.4c: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. Focus on formulas in which the variable of interest is linear or square.
- OH.Math.HSA.CED.4d: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. While functions will often be linear, exponential, or quadratic, the types of problems should draw from more complicated situations.
- OH.Math.HSA.SSE.1b: Interpret expressions that represent a quantity in terms of its context. Interpret complicated expressions by viewing one or more of their parts as a single entity.
- OH.Math.HSA.CED.4a: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. Focus on formulas in which the variable of interest is linear or square.

Unit 2: Functions

- **FUNCTIONS AND RELATIONS**
  - OH.Math.HSF.IF.2: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
  - OH.Math.HSF.IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
  - OH.Math.HSF.IF.4b: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Focus on linear, quadratic, and exponential functions.
  - OH.Math.HSF.IF.5c: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Emphasize the selection of a type of function for a model based on behavior of data and context.
  - OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
  - OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
  - OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function

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and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().

- OH.Math.HSF.IF.5b: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear, quadratic, and exponential functions.
- OH.Math.HSF.LE.2: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
- OH.Math.HSF.IF.7c: Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular type of function model appropriate. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

- **DOMAIN AND RANGE**
  - OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
  - OH.Math.HSF.IF.5c: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Emphasize the selection of a type of function for a model based on behavior of data and context.
  - OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
  - OH.Math.HSF.IF.5b: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear, quadratic, and exponential functions.
  - OH.Math.HSF.IF.5a: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear and exponential functions.
  - OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
  - OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
  - OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function

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and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().

- OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
- OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().

- **MULTIPLE REPRESENTATIONS OF FUNCTIONS**
  - OH.Math.HSA.CED.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
  - OH.Math.HSF.IF.2: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
  - OH.Math.HSF.IF.9: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
  - OH.Math.HSF.LE.2: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
  - OH.Math.HSA.CED.2c: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Extend to include more complicated function situations with the option to graph with technology.
  - OH.Math.HSF.IF.4a: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Focus on linear and exponential functions.
  - OH.Math.HSF.IF.4b: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Focus on linear, quadratic, and exponential functions.
  - OH.Math.HSF.IF.5b: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear, quadratic, and exponential functions.
  - OH.Math.HSF.IF.9a: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). Focus on linear and exponential functions.
  - OH.Math.HSF.IF.9b: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). Focus on linear, quadratic, and exponential functions.

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- OH.Math.HSA.CED.2a: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying linear and simple exponential expressions.
- OH.Math.HSA.CED.2b: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying simple quadratic expressions.
- OH.Math.HSF.LE.1a: Distinguish between situations that can be modeled with linear functions and with exponential functions. Show that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.
- OH.Math.HSF.BF.1a.ii: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from context. Focus on situations that exhibit quadratic or exponential relationships.

Unit 3: Coordinate Geometry

- **LENGTH AND THE DISTANCE FORMULA**
  - OH.Math.HSG.GPE.6: Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
  - OH.Math.HSG.GPE.7: Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.
  - OH.Math.HSG.MG.1: Use geometric shapes, their measures, and their properties to describe objects, e.g., modeling a tree trunk or a human torso as a cylinder.
  - OH.Math.HSG.CO.1: Know precise definitions of ray, angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and arc length.
- **CONJECTURES IN COORDINATE GEOMETRY**
  - OH.Math.HSG.CO.2: Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not, e.g., translation versus horizontal stretch.
  - OH.Math.HSG.CO.9: Prove and apply theorems about lines and angles.
  - OH.Math.HSG.CO.10: Prove and apply theorems about triangles.
  - OH.Math.HSG.CO.11: Prove and apply theorems about parallelograms.
  - OH.Math.HSG.GPE.4: Use coordinates to prove simple geometric theorems algebraically and to verify geometric relationships algebraically, including properties of special triangles, quadrilaterals, and circles.

Unit 4: Conic Sections

- **CIRCLES**
  - OH.Math.HSG.CO.1: Know precise definitions of ray, angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and arc length.

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- OH.Math.HSG.GMD.4: Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
- OH.Math.HSG.GPE.1: Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

- **PARABOLAS**
  - OH.Math.HSG.GPE.2: Derive the equation of a parabola given a focus and directrix.
  - OH.Math.HSA.CED.2b: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying simple quadratic expressions.
  - OH.Math.HSA.CED.2c: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Extend to include more complicated function situations with the option to graph with technology.
  - OH.Math.HSG.GMD.4: Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Unit 5: Geometric Transformations

- **TRANSFORMATIONS ON THE COORDINATE PLANE**
  - OH.Math.HSG.CO.2: Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not, e.g., translation versus horizontal stretch.
  - OH.Math.HSG.CO.6: Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.
  - OH.Math.HSG.CO.5: Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using items such as graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
  - OH.Math.HSG.GMD.5: Understand how and when changes to the measures of a figure (lengths or angles) result in similar and non-similar figures.
  - OH.Math.HSG.CO.3b: Identify the symmetries of a figure, which are the rotations and reflections that carry it onto itself. Identify figures that have rotational symmetry; determine the angle of rotation, and use rotational symmetry to analyze properties of shapes.
  - OH.Math.HSG.CO.4: Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
  - OH.Math.HSG.SRT.2: Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

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- OH.Math.HSG.SRT.1a: Verify experimentally the properties of dilations given by a center and a scale factor: A dilation takes a line not passing through the center of the dilation to a parallel line and leaves a line passing through the center unchanged.
- OH.Math.HSG.SRT.1b: Verify experimentally the properties of dilations given by a center and a scale factor: The dilation of a line segment is longer or shorter in the ratio given by the scale factor.
- OH.Math.HSG.CO.3a: Identify the symmetries of a figure, which are the rotations and reflections that carry it onto itself. Identify figures that have line symmetry; draw and use lines of symmetry to analyze properties of shapes.

- **DILATIONS, TRANSLATIONS, ROTATIONS, AND REFLECTIONS**
  - OH.Math.HSG.CO.2: Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not, e.g., translation versus horizontal stretch.
  - OH.Math.HSG.CO.6: Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.
  - OH.Math.HSG.CO.4: Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
  - OH.Math.HSG.CO.5: Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using items such as graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
  - OH.Math.HSG.GMD.5: Understand how and when changes to the measures of a figure (lengths or angles) result in similar and non-similar figures.
  - OH.Math.HSG.CO.3b: Identify the symmetries of a figure, which are the rotations and reflections that carry it onto itself. Identify figures that have rotational symmetry; determine the angle of rotation, and use rotational symmetry to analyze properties of shapes.
  - OH.Math.HSG.SRT.1a: Verify experimentally the properties of dilations given by a center and a scale factor: A dilation takes a line not passing through the center of the dilation to a parallel line and leaves a line passing through the center unchanged.
  - OH.Math.HSG.SRT.1b: Verify experimentally the properties of dilations given by a center and a scale factor: The dilation of a line segment is longer or shorter in the ratio given by the scale factor.
  - OH.Math.HSG.SRT.2: Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

Unit 6: Congruence and Similarity

- **TRIANGLES AND CONGRUENCE TRANSFORMATIONS**

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- OH.Math.HSG.CO.6: Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.
- OH.Math.HSG.CO.7: Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.
- OH.Math.HSG.CO.8: Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.
- OH.Math.HSG.CO.10: Prove and apply theorems about triangles.
- OH.Math.HSG.SRT.5: Use congruence and similarity criteria for triangles to solve problems and to justify relationships in geometric figures that can be decomposed into triangles.

- **TRIANGLES AND SIMILARITY TRANSFORMATIONS**
  - OH.Math.HSG.CO.5: Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using items such as graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
  - OH.Math.HSG.CO.10: Prove and apply theorems about triangles.
  - OH.Math.HSG.SRT.2: Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.
  - OH.Math.HSG.SRT.3: Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.
  - OH.Math.HSG.SRT.4: Prove and apply theorems about triangles.
  - OH.Math.HSG.SRT.5: Use congruence and similarity criteria for triangles to solve problems and to justify relationships in geometric figures that can be decomposed into triangles.
  - OH.Math.HSG.GMD.5: Understand how and when changes to the measures of a figure (lengths or angles) result in similar and non-similar figures.
- **SIMILARITY OF OTHER POLYGONS**
  - OH.Math.HSG.SRT.2: Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.
  - OH.Math.HSG.GMD.5: Understand how and when changes to the measures of a figure (lengths or angles) result in similar and non-similar figures.
  - OH.Math.HSG.GMD.6: When figures are similar, understand and apply the fact that when a figure is scaled by a factor of , the effect on lengths, areas, and volumes is that they are multiplied by , , and , respectively.

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- OH.Math.HSG.CO.5: Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using items such as graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
- OH.Math.HSG.SRT.3: Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.
- OH.Math.HSG.GMD.6: When figures are similar, understand and apply the fact that when a figure is scaled by a factor of , the effect on lengths, areas, and volumes is that they are multiplied by , , and , respectively.

Unit 7: Triangles

- **TRIANGLE ANGLE THEOREMS**
  - OH.Math.HSG.CO.10: Prove and apply theorems about triangles.
  - OH.Math.HSG.SRT.4: Prove and apply theorems about triangles.
- **TRIANGLE BISECTORS**
  - OH.Math.HSG.CO.9: Prove and apply theorems about lines and angles.
  - OH.Math.HSG.CO.10: Prove and apply theorems about triangles.
  - OH.Math.HSG.SRT.4: Prove and apply theorems about triangles.
  - OH.Math.HSG.SRT.5: Use congruence and similarity criteria for triangles to solve problems and to justify relationships in geometric figures that can be decomposed into triangles.
  - OH.Math.HSG.CO.12: Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.).
  - OH.Math.HSG.C.3: Construct the inscribed and circumscribed circles of a triangle; prove and apply the property that opposite angles are supplementary for a quadrilateral inscribed in a circle.
- **MEDIANS AND ALTITUDES OF TRIANGLES**
  - OH.Math.HSG.CO.10: Prove and apply theorems about triangles.
  - OH.Math.HSG.SRT.4: Prove and apply theorems about triangles.

Unit 8: Triangles and Trigonometry

- **THE PYTHAGOREAN THEOREM**
  - OH.Math.HSG.SRT.8a: Solve problems involving right triangles. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems if one of the two acute angles and a side length is given.
  - OH.Math.HSG.SRT.8b: Solve problems involving right triangles. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.
  - OH.Math.HSG.MG.1: Use geometric shapes, their measures, and their properties to describe objects, e.g., modeling a tree trunk or a human torso as a cylinder.

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- OH.Math.HSG.CO.10: Prove and apply theorems about triangles.
- OH.Math.HSG.SRT.4: Prove and apply theorems about triangles.
- OH.Math.HSG.SRT.5: Use congruence and similarity criteria for triangles to solve problems and to justify relationships in geometric figures that can be decomposed into triangles.

- **TRIGONOMETRIC RATIOS**
  - OH.Math.HSF.TF.3: Use special triangles to determine geometrically the values of sine, cosine, tangent for /3, /4, and /6, and use the unit circle to express the values of sine, cosine, and tangent for , + , and 2 in terms of their values for , where is any real number.
  - OH.Math.HSG.SRT.6: Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.
  - OH.Math.HSG.SRT.7: Explain and use the relationship between the sine and cosine of complementary angles.
  - OH.Math.HSG.SRT.8a: Solve problems involving right triangles. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems if one of the two acute angles and a side length is given.
  - OH.Math.HSG.SRT.8b: Solve problems involving right triangles. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.
  - OH.Math.HSF.TF.3: Use special triangles to determine geometrically the values of sine, cosine, tangent for /3, /4, and /6, and use the unit circle to express the values of sine, cosine, and tangent for , + , and 2 in terms of their values for , where is any real number.
  - OH.Math.HSF.TF.3: Use special triangles to determine geometrically the values of sine, cosine, tangent for /3, /4, and /6, and use the unit circle to express the values of sine, cosine, and tangent for , + , and 2 in terms of their values for , where is any real number.
  - OH.Math.HSG.SRT.5: Use congruence and similarity criteria for triangles to solve problems and to justify relationships in geometric figures that can be decomposed into triangles.
  - OH.Math.HSG.MG.1: Use geometric shapes, their measures, and their properties to describe objects, e.g., modeling a tree trunk or a human torso as a cylinder.

Unit 9: Advanced Circle Properties

- **CONGRUENT AND SIMILAR CIRCLES**
  - OH.Math.HSG.CO.1: Know precise definitions of ray, angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and arc length.
  - OH.Math.HSG.C.1: Prove that all circles are similar using transformational arguments.
  - OH.Math.HSG.CO.6: Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

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- OH.Math.HSG.CO.4: Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
- OH.Math.HSG.CO.5: Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using items such as graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
- OH.Math.HSG.SRT.2: Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.
- OH.Math.HSG.GPE.4: Use coordinates to prove simple geometric theorems algebraically and to verify geometric relationships algebraically, including properties of special triangles, quadrilaterals, and circles.
- OH.Math.HSG.SRT.1a: Verify experimentally the properties of dilations given by a center and a scale factor: A dilation takes a line not passing through the center of the dilation to a parallel line and leaves a line passing through the center unchanged.

- **CIRCUMFERENCE AND ARC LENGTH**
  - OH.Math.HSG.CO.1: Know precise definitions of ray, angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and arc length.
  - OH.Math.HSG.GPE.4: Use coordinates to prove simple geometric theorems algebraically and to verify geometric relationships algebraically, including properties of special triangles, quadrilaterals, and circles.
  - OH.Math.HSG.GMD.1: Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder, pyramid, and cone.
  - OH.Math.HSG.C.5a: Find arc lengths and areas of sectors of circles. Apply similarity to relate the length of an arc intercepted by a central angle to the radius. Use the relationship to solve problems.
  - OH.Math.HSG.C.6: Derive formulas that relate degrees and radians, and convert between the two.
  - OH.Math.HSG.MG.1: Use geometric shapes, their measures, and their properties to describe objects, e.g., modeling a tree trunk or a human torso as a cylinder.
- **AREA OF CIRCLES AND SECTORS**
  - OH.Math.HSG.GMD.1: Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder, pyramid, and cone.
  - OH.Math.HSG.C.5b: Find arc lengths and areas of sectors of circles. Derive the formula for the area of a sector, and use it to solve problems.
  - OH.Math.HSG.C.6: Derive formulas that relate degrees and radians, and convert between the two.
  - OH.Math.HSG.MG.1: Use geometric shapes, their measures, and their properties to describe objects, e.g., modeling a tree trunk or a human torso as a cylinder.

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- OH.Math.HSG.CO.1: Know precise definitions of ray, angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and arc length.

Unit 10: Exponential Functions, Equations, and Inequalities

- **EXPONENTIAL FUNCTIONS**
  - OH.Math.HSA.SSE.1a: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients.
  - OH.Math.HSA.SSE.1b: Interpret expressions that represent a quantity in terms of its context. Interpret complicated expressions by viewing one or more of their parts as a single entity.
  - OH.Math.HSA.SSE.3c: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Use the properties of exponents to transform expressions for exponential functions.
  - OH.Math.HSF.IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
  - OH.Math.HSF.LE.5: Interpret the parameters in a linear or exponential function in terms of a context.
  - OH.Math.HSF.IF.7e: Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular type of function model appropriate. Graph simple exponential functions, indicating intercepts and end behavior.
  - OH.Math.HSF.IF.7f: Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular type of function model appropriate. Graph exponential functions, indicating intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.
  - OH.Math.HSF.LE.1a: Distinguish between situations that can be modeled with linear functions and with exponential functions. Show that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.
  - OH.Math.HSF.IF.4a: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Focus on linear and exponential functions.
  - OH.Math.HSF.IF.8b.i: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Use the properties of exponents to interpret expressions for exponential functions. Focus on exponential functions evaluated at integer inputs.
  - OH.Math.HSF.IF.6: Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.
  - OH.Math.HSF.LE.2: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

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- OH.Math.HSF.LE.3: Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly or quadratically.
- OH.Math.HSF.IF.8b: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Use the properties of exponents to interpret expressions for exponential functions.
- OH.Math.HSF.LE.1c: Distinguish between situations that can be modeled with linear functions and with exponential functions. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
- OH.Math.HSF.IF.4b: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Focus on linear, quadratic, and exponential functions.
- OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
- OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
- OH.Math.HSF.IF.5b: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear, quadratic, and exponential functions.
- OH.Math.HSF.IF.5a: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear and exponential functions.
- OH.Math.HSA.CED.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- OH.Math.HSA.REI.3: Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
- OH.Math.HSA.REI.10: Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
- OH.Math.HSF.IF.7g: Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular type of function model appropriate. Graph rational functions, identifying zeros and asymptotes when factoring is reasonable, and indicating end behavior.
- OH.Math.HSA.CED.1a: Create equations and inequalities in one variable and use them to solve problems. Focus on applying linear and simple exponential expressions.
- OH.Math.HSA.CED.1c: Create equations and inequalities in one variable and use them to solve problems. Extend to include more complicated function situations with the option to solve with

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technology.

- OH.Math.HSA.CED.2a: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying linear and simple exponential expressions.
- OH.Math.HSA.CED.2c: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Extend to include more complicated function situations with the option to graph with technology.
- OH.Math.HSF.BF.1a.i: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from context. Focus on linear and exponential functions.
- OH.Math.HSF.BF.1a.ii: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from context. Focus on situations that exhibit quadratic or exponential relationships.

- **EXPONENTIAL GROWTH AND DECAY**
  - OH.Math.HSA.CED.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
  - OH.Math.HSA.SSE.1a: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients.
  - OH.Math.HSA.SSE.1b: Interpret expressions that represent a quantity in terms of its context. Interpret complicated expressions by viewing one or more of their parts as a single entity.
  - OH.Math.HSF.LE.2: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
  - OH.Math.HSF.LE.5: Interpret the parameters in a linear or exponential function in terms of a context.
  - OH.Math.HSF.IF.8b: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Use the properties of exponents to interpret expressions for exponential functions.
  - OH.Math.HSF.LE.1a: Distinguish between situations that can be modeled with linear functions and with exponential functions. Show that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.
  - OH.Math.HSF.LE.1c: Distinguish between situations that can be modeled with linear functions and with exponential functions. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
  - OH.Math.HSA.CED.2a: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying linear and simple exponential expressions.

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- OH.Math.HSF.IF.8a.i: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. Focus on completing the square to quadratic functions with the leading coefficient of 1.
- OH.Math.HSF.IF.8b.i: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Use the properties of exponents to interpret expressions for exponential functions. Focus on exponential functions evaluated at integer inputs.
- OH.Math.HSA.SSE.3c: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Use the properties of exponents to transform expressions for exponential functions.
- OH.Math.HSA.REI.10: Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
- OH.Math.HSF.LE.3: Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly or quadratically.
- OH.Math.HSF.LE.1b: Distinguish between situations that can be modeled with linear functions and with exponential functions. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
- OH.Math.HSF.IF.4a: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Focus on linear and exponential functions.
- OH.Math.HSF.IF.4b: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Focus on linear, quadratic, and exponential functions.
- OH.Math.HSF.IF.5b: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear, quadratic, and exponential functions.
- OH.Math.HSF.IF.5a: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear and exponential functions.
- OH.Math.HSA.CED.2c: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Extend to include more complicated function situations with the option to graph with technology.
- OH.Math.HSF.IF.7e: Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular type of function model appropriate. Graph simple exponential functions, indicating intercepts and end behavior.
- OH.Math.HSF.IF.7f: Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular type of function

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model appropriate. Graph exponential functions, indicating intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

- OH.Math.HSA.CED.2b: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying simple quadratic expressions.
- OH.Math.HSF.BF.1a.i: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from context. Focus on linear and exponential functions.
- OH.Math.HSF.BF.1a.ii: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from context. Focus on situations that exhibit quadratic or exponential relationships.

Unit 11: Polynomials

- **POLYNOMIAL BASICS**
  - OH.Math.HSA.SSE.1a: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients.
  - OH.Math.HSA.SSE.1b: Interpret expressions that represent a quantity in terms of its context. Interpret complicated expressions by viewing one or more of their parts as a single entity.
  - OH.Math.HSA.SSE.2: Use the structure of an expression to identify ways to rewrite it.
  - OH.Math.HSA.APR.1: Understand that polynomials form a system analogous to the integers, namely, that they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.
  - OH.Math.HSA.APR.1b: Understand that polynomials form a system analogous to the integers, namely, that they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. Extend to polynomial expressions beyond those expressions that simplify to forms that are linear or quadratic.
  - OH.Math.HSA.APR.1a: Understand that polynomials form a system analogous to the integers, namely, that they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. Focus on polynomial expressions that simplify to forms that are linear or quadratic.
- **ADDITION AND SUBTRACTION OF POLYNOMIALS**
  - OH.Math.HSA.APR.1b: Understand that polynomials form a system analogous to the integers, namely, that they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. Extend to polynomial expressions beyond those expressions that simplify to forms that are linear or quadratic.
  - OH.Math.HSA.APR.1a: Understand that polynomials form a system analogous to the integers, namely, that they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. Focus on polynomial expressions that simplify to forms that are linear or quadratic.

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- OH.Math.HSA.SSE.2: Use the structure of an expression to identify ways to rewrite it.

- **MULTIPLICATION OF POLYNOMIALS**
  - OH.Math.HSA.APR.1b: Understand that polynomials form a system analogous to the integers, namely, that they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. Extend to polynomial expressions beyond those expressions that simplify to forms that are linear or quadratic.
  - OH.Math.HSA.APR.1a: Understand that polynomials form a system analogous to the integers, namely, that they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. Focus on polynomial expressions that simplify to forms that are linear or quadratic.
  - OH.Math.HSA.SSE.2: Use the structure of an expression to identify ways to rewrite it.

Unit 12: Factoring

- **FACTORING QUADRATIC TRINOMIALS**
  - OH.Math.HSA.SSE.2: Use the structure of an expression to identify ways to rewrite it.
  - OH.Math.HSA.SSE.3a: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Factor a quadratic expression to reveal the zeros of the function it defines.
  - OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
  - OH.Math.HSA.SSE.1a: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients.
  - OH.Math.HSA.SSE.1b: Interpret expressions that represent a quantity in terms of its context. Interpret complicated expressions by viewing one or more of their parts as a single entity.
  - OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.

- **FACTORING SPECIAL CASES**
  - OH.Math.HSA.SSE.2: Use the structure of an expression to identify ways to rewrite it.
  - OH.Math.HSA.SSE.1a: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients.
  - OH.Math.HSA.SSE.1b: Interpret expressions that represent a quantity in terms of its context. Interpret complicated expressions by viewing one or more of their parts as a single entity.
  - OH.Math.HSA.SSE.3a: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Factor a quadratic expression to reveal the

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zeros of the function it defines.

- OH.Math.HSA.APR.3: Identify zeros of polynomials, when factoring is reasonable, and use the zeros to construct a rough graph of the function defined by the polynomial.
- OH.Math.HSA.APR.4: Prove polynomial identities and use them to describe numerical relationships.

Unit 13: Representations of Quadratic Functions

- **QUADRATIC FUNCTIONS**
  - OH.Math.HSF.IF.7b: Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular type of function model appropriate. Graph quadratic functions and indicate intercepts, maxima, and minima.
  - OH.Math.HSA.CED.1b: Create equations and inequalities in one variable and use them to solve problems. Focus on applying simple quadratic expressions.
  - OH.Math.HSA.CED.2b: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying simple quadratic expressions.
  - OH.Math.HSF.IF.4b: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Focus on linear, quadratic, and exponential functions.
  - OH.Math.HSF.BF.1a.ii: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from context. Focus on situations that exhibit quadratic or exponential relationships.
  - OH.Math.HSA.CED.2c: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Extend to include more complicated function situations with the option to graph with technology.
  - OH.Math.HSA.SSE.1a: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients.
  - OH.Math.HSA.SSE.1b: Interpret expressions that represent a quantity in terms of its context. Interpret complicated expressions by viewing one or more of their parts as a single entity.
- **ANALYZING GRAPHS OF QUADRATIC FUNCTIONS**
  - OH.Math.HSA.SSE.2: Use the structure of an expression to identify ways to rewrite it.
  - OH.Math.HSF.IF.2: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
  - OH.Math.HSF.IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
  - OH.Math.HSF.IF.4b: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features

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given a verbal description of the relationship. Focus on linear, quadratic, and exponential functions.

- OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
- OH.Math.HSF.IF.5b: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear, quadratic, and exponential functions.
- OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
- OH.Math.HSF.IF.7b: Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular type of function model appropriate. Graph quadratic functions and indicate intercepts, maxima, and minima.
- OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().
- OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().
- OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
- OH.Math.HSF.IF.5: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
- OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
- OH.Math.HSA.CED.2b: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying simple quadratic expressions.

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- OH.Math.HSA.APR.3: Identify zeros of polynomials, when factoring is reasonable, and use the zeros to construct a rough graph of the function defined by the polynomial.

- **REPRESENTATIONS OF QUADRATIC FUNCTIONS**
  - OH.Math.HSA.SSE.2: Use the structure of an expression to identify ways to rewrite it.
  - OH.Math.HSA.REI.4a: Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in into an equation of the form ( ) = that has the same solutions.
  - OH.Math.HSA.REI.4c: Solve quadratic equations in one variable. Derive the quadratic formula using the method of completing the square.
  - OH.Math.HSA.CED.1c: Create equations and inequalities in one variable and use them to solve problems. Extend to include more complicated function situations with the option to solve with technology.
  - OH.Math.HSA.CED.2b: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying simple quadratic expressions.
  - OH.Math.HSA.CED.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
  - OH.Math.HSA.CED.3: Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context.
  - OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
  - OH.Math.HSF.IF.2: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
  - OH.Math.HSF.IF.7b: Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular type of function model appropriate. Graph quadratic functions and indicate intercepts, maxima, and minima.
  - OH.Math.HSF.IF.8a: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
  - OH.Math.HSA.CED.2c: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Extend to include more complicated function situations with the option to graph with technology.
  - OH.Math.HSF.IF.4b: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features

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given a verbal description of the relationship. Focus on linear, quadratic, and exponential functions.

- OH.Math.HSF.IF.5b: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear, quadratic, and exponential functions.
- OH.Math.HSF.IF.8a.i: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. Focus on completing the square to quadratic functions with the leading coefficient of 1.
- OH.Math.HSF.BF.1a.ii: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from context. Focus on situations that exhibit quadratic or exponential relationships.
- OH.Math.HSF.IF.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
- OH.Math.HSA.CED.2a: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying linear and simple exponential expressions.
- OH.Math.HSA.SSE.1b: Interpret expressions that represent a quantity in terms of its context. Interpret complicated expressions by viewing one or more of their parts as a single entity.
- OH.Math.HSA.SSE.3a: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Factor a quadratic expression to reveal the zeros of the function it defines.
- OH.Math.HSA.REI.4a: Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in into an equation of the form ( ) = that has the same solutions.
- OH.Math.HSF.BF.3: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.
- OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().

Unit 14: Transformations of Parent Functions

- **QUADRATIC PARENT FUNCTION**
  - OH.Math.HSA.REI.10: Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

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- OH.Math.HSF.IF.5: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
- OH.Math.HSF.IF.7b: Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular type of function model appropriate. Graph quadratic functions and indicate intercepts, maxima, and minima.
- OH.Math.HSF.IF.4b: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Focus on linear, quadratic, and exponential functions.
- OH.Math.HSF.IF.5b: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear, quadratic, and exponential functions.
- OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().
- OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().

- **TRANSFORMATIONS OF THE QUADRATIC PARENT FUNCTION**
  - OH.Math.HSG.CO.2: Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not, e.g., translation versus horizontal stretch.
  - OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().
  - OH.Math.HSA.CED.2b: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying simple quadratic expressions.
  - OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().

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- OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().
- OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().
- OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
- OH.Math.HSF.IF.5b: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear, quadratic, and exponential functions.
- OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().

- **TRANSFORMATIONS OF THE LINEAR AND EXPONENTIAL PARENT FUNCTIONS**
  - OH.Math.HSG.CO.2: Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not, e.g., translation versus horizontal stretch.
  - OH.Math.HSG.CO.6: Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.
  - OH.Math.HSG.SRT.1a: Verify experimentally the properties of dilations given by a center and a scale factor: A dilation takes a line not passing through the center of the dilation to a parallel line and leaves a line passing through the center unchanged.
  - OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().
  - OH.Math.HSA.SSE.3c: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Use the properties of exponents to

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transform expressions for exponential functions.

- OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().
- OH.Math.HSA.REI.10: Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
- OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().
- OH.Math.HSF.LE.2: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
- OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().
- OH.Math.HSF.LE.5: Interpret the parameters in a linear or exponential function in terms of a context.
- OH.Math.HSF.IF.4a: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Focus on linear and exponential functions.
- OH.Math.HSF.BF.1a.i: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from context. Focus on linear and exponential functions.
- OH.Math.HSF.BF.3a: Identify the effect on the graph of replacing () by () + , (), (), and (+) for specific values of (both positive and negative); find the value of given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Focus on transformations of graphs of quadratic functions, except for ().
- OH.Math.HSF.IF.5a: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. Focus on linear and exponential functions.

Unit 15: Solving Quadratic Equations

- **SOLVING QUADRATIC EQUATIONS BY FACTORING**

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- OH.Math.HSA.APR.3: Identify zeros of polynomials, when factoring is reasonable, and use the zeros to construct a rough graph of the function defined by the polynomial.
- OH.Math.HSA.SSE.3a: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Factor a quadratic expression to reveal the zeros of the function it defines.
- OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
- OH.Math.HSA.APR.4: Prove polynomial identities and use them to describe numerical relationships.
- OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
- OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
- OH.Math.HSF.IF.8a.i: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. Focus on completing the square to quadratic functions with the leading coefficient of 1.
- OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
- OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
- OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
- OH.Math.HSF.IF.7b: Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular type of function model appropriate. Graph quadratic functions and indicate intercepts, maxima, and minima.

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- OH.Math.HSF.IF.8a: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
- OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
- OH.Math.HSA.CED.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- OH.Math.HSA.CED.2b: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying simple quadratic expressions.
- OH.Math.HSA.CED.2c: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Extend to include more complicated function situations with the option to graph with technology.
- OH.Math.HSF.BF.1a.ii: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from context. Focus on situations that exhibit quadratic or exponential relationships.

- **COMPLETING THE SQUARE**
  - OH.Math.HSA.SSE.3b: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
  - OH.Math.HSA.REI.4a: Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in into an equation of the form ( ) = that has the same solutions.
  - OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
  - OH.Math.HSF.IF.8a: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
  - OH.Math.HSF.IF.8a.i: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. Focus on completing the square to quadratic functions with the leading coefficient of 1.

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- OH.Math.HSA.SSE.2: Use the structure of an expression to identify ways to rewrite it.
- OH.Math.HSA.REI.4a: Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in into an equation of the form ( ) = that has the same solutions.
- OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
- OH.Math.HSA.CED.2b: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying simple quadratic expressions.
- OH.Math.HSA.REI.4a: Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in into an equation of the form ( ) = that has the same solutions.
- OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
- OH.Math.HSA.REI.4c: Solve quadratic equations in one variable. Derive the quadratic formula using the method of completing the square.
- OH.Math.HSF.IF.7b: Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular type of function model appropriate. Graph quadratic functions and indicate intercepts, maxima, and minima.
- OH.Math.HSA.REI.4a: Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in into an equation of the form ( ) = that has the same solutions.

- **QUADRATIC FORMULA**
  - OH.Math.HSA.SSE.1a: Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients.
  - OH.Math.HSA.SSE.1b: Interpret expressions that represent a quantity in terms of its context. Interpret complicated expressions by viewing one or more of their parts as a single entity.
  - OH.Math.HSA.REI.4a: Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in into an equation of the form ( ) = that has the same solutions.
  - OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots;

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completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.

- OH.Math.HSA.REI.4c: Solve quadratic equations in one variable. Derive the quadratic formula using the method of completing the square.
- OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
- OH.Math.HSF.IF.1: Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If is a function and is an element of its domain, then () denotes the output of corresponding to the input . The graph of is the graph of the equation = ().
- OH.Math.HSF.IF.4b: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Focus on linear, quadratic, and exponential functions.
- OH.Math.HSA.REI.4a: Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in into an equation of the form ( ) = that has the same solutions.
- OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
- OH.Math.HSA.CED.3a: Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. While functions will often be linear, exponential, or quadratic, the types of problems should draw from more complicated situations.
- OH.Math.HSA.REI.4b: Solve quadratic equations in one variable. Solve quadratic equations as appropriate to the initial form of the equation by inspection, e.g., for = 49; taking square roots; completing the square; applying the quadratic formula; or utilizing the Zero-Product Property after factoring.
- OH.Math.HSA.CED.2b: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Focus on applying simple quadratic expressions.
- OH.Math.HSA.APR.1a: Understand that polynomials form a system analogous to the integers, namely, that they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. Focus on polynomial expressions that simplify to forms that are linear or quadratic.
- OH.Math.HSF.IF.2: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

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- OH.Math.HSF.BF.1a.ii: Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from context. Focus on situations that exhibit quadratic or exponential relationships.

Unit 16: Systems of Nonlinear Equations

- **SYSTEMS OF NONLINEAR EQUATIONS**
  - OH.Math.HSA.REI.7: Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.
  - OH.Math.HSA.REI.5: Verify that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
  - OH.Math.HSA.REI.11: Explain why the -coordinates of the points where the graphs of the equation = () and = () intersect are the solutions of the equation () = (); find the solutions approximately, e.g., using technology to graph the functions, making tables of values, or finding successive approximations.
  - OH.Math.HSA.CED.3a: Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. While functions will often be linear, exponential, or quadratic, the types of problems should draw from more complicated situations.
  - OH.Math.HSA.CED.4d: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. While functions will often be linear, exponential, or quadratic, the types of problems should draw from more complicated situations.
  - OH.Math.HSA.REI.11: Explain why the -coordinates of the points where the graphs of the equation = () and = () intersect are the solutions of the equation () = (); find the solutions approximately, e.g., using technology to graph the functions, making tables of values, or finding successive approximations.
  - OH.Math.HSA.REI.11: Explain why the -coordinates of the points where the graphs of the equation = () and = () intersect are the solutions of the equation () = (); find the solutions approximately, e.g., using technology to graph the functions, making tables of values, or finding successive approximations.
  - OH.Math.HSF.LE.2: Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

Unit 17: Volume

- **RELATING TWO-DIMENSIONAL FIGURES TO THREE-DIMENSIONAL SOLIDS**
  - OH.Math.HSG.GMD.4: Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
  - OH.Math.HSG.CO.14: Classify two-dimensional figures in a hierarchy based on properties.
- **VOLUME OF PRISMS AND PYRAMIDS**
  - OH.Math.HSG.GMD.2: Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.

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- OH.Math.HSG.GMD.3: Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.
- OH.Math.HSG.GMD.1: Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder, pyramid, and cone.
- OH.Math.HSG.GMD.2: Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.
- OH.Math.HSG.MG.1: Use geometric shapes, their measures, and their properties to describe objects, e.g., modeling a tree trunk or a human torso as a cylinder.
- OH.Math.HSG.GMD.2: Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.
- OH.Math.HSG.GMD.4: Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

- **VOLUME OF CYLINDERS AND CONES**
  - OH.Math.HSG.GMD.1: Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder, pyramid, and cone.
  - OH.Math.HSG.GMD.2: Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.
  - OH.Math.HSG.GMD.3: Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.
  - OH.Math.HSG.GMD.2: Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.
  - OH.Math.HSG.MG.1: Use geometric shapes, their measures, and their properties to describe objects, e.g., modeling a tree trunk or a human torso as a cylinder.
  - OH.Math.HSG.GMD.2: Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.
  - OH.Math.HSG.GMD.4: Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Unit 18: Modeling with Geometry

- **VOLUME OF COMPOSITE SOLIDS**
  - OH.Math.HSG.GMD.4: Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
  - OH.Math.HSG.MG.1: Use geometric shapes, their measures, and their properties to describe objects, e.g., modeling a tree trunk or a human torso as a cylinder.
  - OH.Math.HSG.GMD.3: Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

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- OH.Math.HSG.GMD.1: Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder, pyramid, and cone.
- OH.Math.HSG.GMD.2: Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.
- OH.Math.HSG.MG.3: Apply geometric methods to solve design problems, e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios.

- **MODELING SITUATIONS WITH GEOMETRY**
  - OH.Math.HSG.MG.2: Apply concepts of density based on area and volume in modeling situations, e.g., persons per square mile, BTUs per cubic foot.
  - OH.Math.HSG.MG.3: Apply geometric methods to solve design problems, e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios.
  - OH.Math.HSG.MG.1: Use geometric shapes, their measures, and their properties to describe objects, e.g., modeling a tree trunk or a human torso as a cylinder.

Unit 19: Probability Concepts

- **INTRODUCTION TO PROBABILITY**
  - OH.Math.HSS.CP.2: Understand that two events A and B are independent if and only if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
  - OH.Math.HSS.CP.8: Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(BA) = P(B)P(AB), and interpret the answer in terms of the model.
  - OH.Math.HSS.CP.1: Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (or, and, not).
  - OH.Math.HSS.CP.3: Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.
  - OH.Math.HSS.CP.5: Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.
  - OH.Math.HSS.CP.8: Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(BA) = P(B)P(AB), and interpret the answer in terms of the model.
  - OH.Math.HSS.CP.7: Apply the Addition Rule, P(A or B) = P(A) + P(B) P(A and B), and interpret the answer in terms of the model.
  - OH.Math.HSS.CP.8: Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(BA) = P(B)P(AB), and interpret the answer in terms of the model.
- **COMBINATIONS AND PERMUTATIONS**

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- OH.Math.HSS.CP.9: Use permutations and combinations to compute probabilities of compound events and solve problems.

- **CONDITIONAL PROBABILITY**
  - OH.Math.HSS.CP.3: Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.
  - OH.Math.HSS.CP.5: Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.
  - OH.Math.HSS.CP.6: Find the conditional probability of A given B as the fraction of Bs outcomes that also belong to A, and interpret the answer in terms of the model.
  - OH.Math.HSS.CP.1: Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (or, and, not).
  - OH.Math.HSS.CP.2: Understand that two events A and B are independent if and only if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
  - OH.Math.HSS.CP.6: Find the conditional probability of A given B as the fraction of Bs outcomes that also belong to A, and interpret the answer in terms of the model.
  - OH.Math.HSS.ID.5: Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.
  - OH.Math.HSS.CP.4: Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities.
  - OH.Math.HSS.CP.1: Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (or, and, not).
  - OH.Math.HSS.CP.6: Find the conditional probability of A given B as the fraction of Bs outcomes that also belong to A, and interpret the answer in terms of the model.
  - OH.Math.HSS.CP.6: Find the conditional probability of A given B as the fraction of Bs outcomes that also belong to A, and interpret the answer in terms of the model.
  - OH.Math.HSS.CP.6: Find the conditional probability of A given B as the fraction of Bs outcomes that also belong to A, and interpret the answer in terms of the model.

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