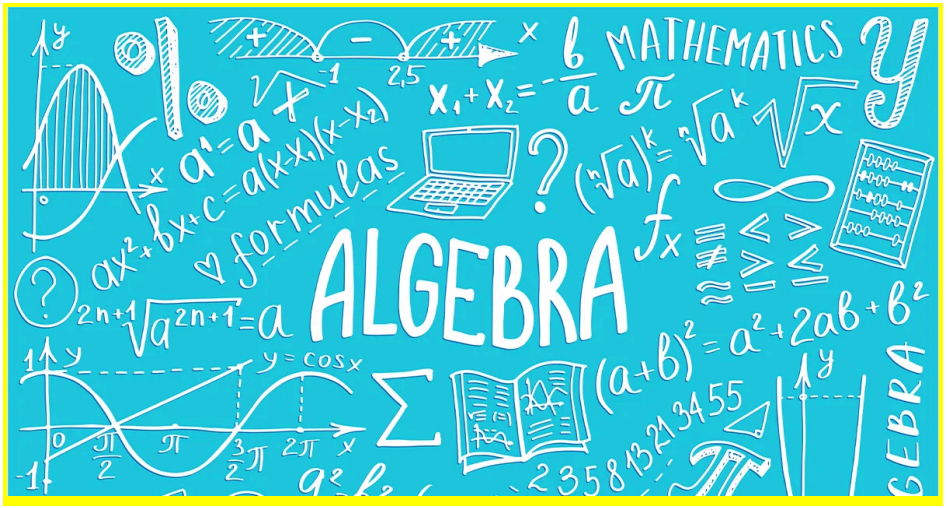
# ADVANCED 8TH GRADE MATH CURRICULUM




REGION 14 SCHOOL DISTRICT
VISION OF A LEARNER

**Grade Level(s):** Advanced 8th Grade Math

**Curriculum Author(s):** Cate Lyman, Connor Mooney

**Course Description: Advanced Math 8** is a high school Algebra course that also includes completing the 8th-grade math standards. Students in this class must be highly motivated, demonstrate strength of the 7th grade standards including algebraic reasoning and numeracy and perseverance while working at a faster pace. In algebra, students learn to model the real world through the study of one- and two-variable statistics, linear equations in one and two variables, systems of linear equations and inequalities, functions, exponential relationships, and quadratic functions. Students learn to represent real-world situations through tables, graphs, and equations and analyze these models to solve problems and make decisions. Students will be expected to clearly communicate in writing and orally using mathematical evidence to support answers. In addition to the standard Algebra curriculum, students will cover many of the 8th-grade topics such as similarity and congruence in 2-dimensional shapes, number systems including irrational numbers, the volume of cylinders, cones, and spheres, bivariate data, and probability in the form of two-way frequency tables, rules of exponents and scientific notation, a study of right triangles and the Pythagorean theorem.***Students will have required math work to complete over the summer.***

| Year At A Glance | | | |
|---|---|---|---|
| **Unit Title** | **Overarching Essential Question** | **Overarching Enduring Understanding** | **Vision of A Learner "I Can" Statements** |
| Solving Linear Equations & Inequalities | How can equations and inequalities be used to model information? | To obtain a solution to an equation, no matter how complex, it always involves the process of undoing the operation. Each step in solving an equation must maintain the equality of the statement. | T13(6-8), **P4**(6-8), TCC2(6-8), **CCE1**(6-8), **DE4**(6-8) |
| Congruence, Dilations and Similarity | How can we use angle relationships and proportional reasoning to understand and compare shapes? | Understanding angle relationships and transformations like dilations helps us explain how shapes relate to one another. These tools allow us to identify when shapes are exactly the same in form and when they are proportionally similar, even if different in size. | TI3(6-8), P4(6-8), TCC2(6-8);CCE1(6-8), CCE3(6-8), DE4(6-8), **TI2**(6-8)**,** P3(6-8) |
| Volume | How do the dimensions of a three-dimensional shape determine how much space it takes up? | Volume formulas show how the size of a shape's dimensions—like radius and height—affect the amount of space it can hold. These formulas help us solve real-world problems involving cylinders, cones, and spheres. | CCE3(6-8), DE4(6-8), P3(6-8), **AA2**(6-8)**, CCE1**(6-8) |
| Linear Functions, Inequalities and Systems | How do systems help us solve real-world problems with multiple constraints? | A solution to a system of equations is the point where all equations intersect. A solution to a system of inequalities is the region of the coordinate plane that contains the ordered pairs that satisfy all of the inequalities. | **TCC1**(6-8), TCC4(6-8), CCE3(6-8), **CCE4**(6-8)**,** DE4(6-8), P3(6-8), AA4(6-8), TI3(6-8) |

| | | | |
|---|---|---|---|
| Pythagorean Theorem And Irrational Numbers | How do geometric relationships and number properties help us solve problems involving distance and irrational numbers? | The Pythagorean Theorem connects geometry and algebra, and understanding irrational numbers expands our view of the number system beyond rational values. | CCE3(6-8), DE4(6-8), P3(6-8), **TCC4**(6-8)**, TCC2**(6-8) |
| Introduction to Statistics | How can we use statistics to summarize and describe sets of data? | Graphs and summary statistics can be used to describe one variable data; scatterplots and trend lines can be used to describe two variable data. | TCC3(6-8), DE3(6-8), TI4(6-8) |
| Exponents and Scientific Notation | How do the properties of exponents and scientific notation help us represent and work with very large or very small numbers? | Exponent rules and scientific notation allow us to represent and manipulate very large or small numbers efficiently, revealing structure and patterns in the number system | **CCE3**(6-8), DE4(6-8), **P3**(6-8) |
| Exponential Functions | What are the characteristics of exponential growth and decay and how is this reflected in real-world phenomena? | Exponential functions represent relationships involving a constant multiplicative rate of change, which represent rapid growth or decay. | TCC3(6-8); TI3(6-8); CCE4(6-8) |
| Operations with Polynomial Expressions | How can you verify two algebraic expressions that appear to be different are equivalent? | Polynomial expressions can be simplified and factored using different strategies. | TCC2(6-8); CCE4(6-8); DE1 (6-8) |
| Introduction to Quadratic Functions | What are the characteristics of quadratic functions and how can they be used to model real-world phenomena? | Understanding multiple representations—graphical, numerical, algebraic, and contextual—of quadratic relationships allows us to analyze and solve real-world problems involving solutions and maximum or minimum values. | TCC3(6-8); AA1(6-8), P1 (6-8) |

# Unit 1 - Solving Linear Equations & Inequalities

## Desired Results - Goals, Transfer, Meaning, Acquisition

**Established Goals:**

**Common Core State Standards** (* indicates a modeling standard. For standards that encompass several different topics/concepts, the bolded part is the focus for this unit. If no bolding, the entire standard pertains to this unit.)

- **A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems.**
- **A.CED.A.3 Represent constraints by equations on inequalities,** and by systems of equations and/or inequalities, and **interpret solutions as viable or nonviable options in a modeling context**.
- **A.CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
- **A.REI.A.1** Explain each step in solving a simple equation as follows from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
- **A.REI.B.3** Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
- **A.SSE.A.1** Interpret expressions that represent a quantity in terms of its context.*
    - **A.SSE.A.1.A** Interpret parts of an expression, such as terms, factors, and coefficients.
- **A.SSE.A.2** Use the structure of an expression to identify ways to rewrite it.
- **A.SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

**Standards for Mathematical Practice**

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

**Vision of A Learner Attributes:** Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- TCC2: I can evaluate data gathered from multiple perspectives and draw conclusions.
- **CCE1**: I can contribute to discussions with my peers/teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully as I apply new knowledge to my thinking.
- **P4**: I can step outside my comfort zone because I recognize that my mistakes are not failures, but rather an opportunity to learn and grow. mistakes as opportunities to learn and grow.
- TI3: I can compose specific questions that are relevant to a task to support my learning.
- **DE4**: I can be respectful and responsible and build positive relationships with all members of the school community.
- P3: I can receive and provide constructive feedback and understand the need to adjust my goals/learning journey.

**Understandings:** Students will understand that...

- Algebra consists of numbers, variables, operations, and rules for relationships between those entities.
- A variable represents an unknown quantity.
- Real-life situations can be modeled algebraically.
- To obtain a solution to an equation, no matter how complex, it always involves the process of undoing the operation. Each step in solving an equation must maintain the equality of the statement.
- Inequalities express a range of possible solutions, rather than a single answer.

**Essential Questions:**

- How can the algebraic properties of real numbers extend beyond integers?
- What methods or strategies do you use to decide how to solve a problem? How does this extend to the validity of a solution to a problem?
- Does each equation have a distinct solution and how do you know?
- How can equations and inequalities be used to model information?
- How do inequality properties compare to those of equations? How are they similar? How are they different? What characteristics drive using an inequality instead of an equal sign?
- What is a solution set for a linear inequality?

**Students will know...**

- Explain the steps in solving equations.
- Understand how the properties of equality and inverse operations are used to solve equations and inequalities in one-variable.

**Students will be able to...**

- Solve multi-step equations, justifying each step in the solving process.
- Solve equations with variables on both sides, including examples of special cases with no solutions or infinite solutions.

| | |
|---|---|
| • Understand the difference between the properties of equality vs. combining like terms and when to use each (seeing structure).<br>• The order of operations and apply it when simplifying expressions or solving equations.<br>• Explain the steps in solving inequalities.<br>• Understand how the properties of inequalities and inverse operations are used to solve inequalities.<br>• Understand the difference between the properties of equations vs the properties of inequalities (i.e.: multiplying or dividing by a negative).<br>• The difference between equations and inequalities.<br>• Some equations have no solution, one solution, or infinitely many solutions.<br>• Inequalities express a range of possible solutions rather than a single answer. | • Rewrite and explain literal equations (equations with formulas).<br>• Translate real-world problems into algebraic equations.<br>• Solve and graph multi-step inequalities in one-variable.<br>• Solve and graph compound inequalities in one-variable.<br>• Model real-world situations using inequalities. Apply compound inequalities to real-world situations. |

**Key Vocabulary:**
**Part 1 Solving Equations:** Argument, Coefficient, Combine Like Terms, Constant, Difference, Distributive Property, Expressions, Equation, Equality, Infinite Solutions, Interpret, Inverse Operation, Justify, Like Terms, Modeling, No Solution, Order of Operations, PEMDAS, Persevere, Product, Properties of Equality, Proportional, Quotient, Rate, Ratio, Solve, Solution, Sum, Term, Variable

**Part 2 Solving Inequalities:** At Least, Compound Inequality, Greater Than, Inequality, Interpret Less Than, Modeling, No More Than, Solution, Solution Set

| **Assessment Evidence** | |
|---|---|
| **Performance Tasks:**<br><br>**P4**, **CCE1**, **DE4**<br><br>End of Unit Assessment<br><br>• Recognizing when equations represent the same relationship.<br>• Using algebraic manipulation to justify equivalence.<br>• Translating a verbal description into an equation.<br>• Solving for a given variable<br>• Analyzing real-world constraints | **Other Evidence:**<br><br>2.1-2.4 Quiz<br>2.5-2.8 Quiz (Literal Equations)<br>Exit Tickets analyzing multi step equations<br>Exit Tickets with student reflections on<br>Various Thinking Tasks using Building Thinking Classrooms instructional strategies. |

- Evaluating statements about solutions using a graph.

- Understanding how changes in one variable affect another in a linear relationship.
- Defining variables clearly.
- Incorporating base costs and per-unit costs into an equation.
- Showing algebraic steps and clearly indicating the solution.
- Isolating a specified variable.
- Applying inverse operations in equations involving multiple variables.
- Creating a table of possible solutions.
- Writing an equation to represent a total weight constraint.
- Graphing the solutions to an equation.
- Determining and interpreting slope in context.

**Learning Plan**

| Lesson Focus | Learning Activities | Standards | VoL Attributes |
|---|---|---|---|
| 1–3: Writing and Modeling with Equations | Model real situations (e.g., pizza party, constraints) using expressions, equations; identify variables. | HSA-CED.A.2, HSA-CED.A.3, HSN-Q.A.2 | TI3, TCC2, P4, CCE1, DE4 |
| 4–5: Equations and Their Solutions / Graphs | Solve single-variable equations; graph linear equations; connect algebraic and graphical forms. | HSA-REI.A.1, HSA-CED.A.4, HSF-IF.A.3 | TI3, TCC2, P4, CCE1 |
| 6–9: Manipulating Equations & Rewriting | Generate equivalent equations; explain transformation steps; choose which variable to isolate. | HSA-REI.A.1, HSA-REI.A.2, HSA-REI.B.3, HSA-CED.A.3, HSA-CED.A.4 | TCC2, P4, CCE1 |
| 10–11: Connecting Equations to Graphs | Interpret slope and intercept graphically; connect structure of equation to visual features. | HSA-REI.D.10, HSF-IF.B.6, HSF-LE.A.1 | TI3, TCC2, P4, CCE1, DE4 |

**Teacher Resources:** Algebra 1 Textbooks; IM Algebra 1 Unit 2: Linear Equations, Inequalities, and Systems; State of CT Algebra 1 Model Curriculum Unit 2; Desmos; IXL; TI Smartview Software; Teacher created in-class notes, activities, and problem sets

# Unit 2 - Congruence, Dilations, and Similarity

## Desired Results - Goals, Transfer, Meaning, Acquisition

**Established Goals:**
8.G.A.1: Understand that a dilation is defined by a center and a scale factor; analyze images of circles and lines under dilation.
8.G.A.2: Understand similarity by connecting dilations and rigid motions to define when figures are similar.
8.G.A.3: Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.
8.G.A.4 Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.
8.G.A.3 / 8.EE.B.6: Use similarity (including slope triangles) to understand that any two points on a line determine the same slope.
8.G.A.5 Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles.

**Standards for Mathematical Practice**

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

**Vision of A Learner Attributes:** Students will be able to independently use their learning to...

TCC2: I can evaluate data gathered from multiple perspectives and draw conclusions.

CCE1:I can contribute to discussions with my peers/teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully as I apply new knowledge to my thinking.

P4: I can step outside my comfort zone because I recognize that my mistakes are not failures, but rather an opportunity to learn and grow. mistakes as opportunities to learn and grow.

TI3: I can compose specific questions that are relevant to a task to support my learning.

**DE4**: I can be respectful and responsible and build positive relationships with all members of the school community.

P3:  I can receive and provide constructive feedback and understand the need to adjust my goals/learning journey.

CCE3: I can participate in collaborative conversations by actively listening, formulating questions ,making connected comments and providing various types of feedback to my peers.

**T12**: I can identify my objectives and apply the best resources to my learning.

| **Understandings:** Students will understand that... | **Essential Questions:** |
|---|---|
| Angle relationships in triangles and between parallel lines and transversals follow consistent, predictable patterns.<br><br>Informal reasoning and visual models can justify geometric facts like the angle sum of a triangle or relationships formed by transversals.<br><br>A dilation scales distances from a center by a constant factor while preserving angle measures.<br><br>Two figures are similar if one can be obtained from the other via rigid motions and dilation.<br><br>All slope triangles on the same line are similar, yielding a consistent slope that defines the relationship between vertical and horizontal change. | What angle relationships always exist in triangles and with parallel lines?<br><br>How does changing the scale of a figure affect its size and shape?<br><br>What criteria determine whether two figures are similar?<br><br>How do similar triangles help us understand slope and describe lines? |
| **Students will know...** | **Students will be able to…** |
| Properties of angle relationships: vertical, adjacent, complementary, supplementary, corresponding, alternate interior. | Use informal arguments to justify angle relationships in geometric figures and with parallel lines. |

| | |
|---|---|
| That the sum of the angles in a triangle is always 180°, and how to justify that informally.<br><br>That dilations preserve angle size but scale length by the factor<br><br>That similarity of triangles underpins the concept of slope | Construct dilations on and off the grid using a given center and factor<br><br>Identify when two figures are similar and justify using transformations |
| **Key Vocabulary:** Dilation, Scale Factor, Center of Dilation, Similarity, Slope, Slope Triangle**,** Rigid transformation, Translation, Rotation, Reflection, Congruent, Coordinates, Sequence of transformations, Image, Pre-image, Angle Sum, Transversal, Alternate Interior Angles, Corresponding Angles, Vertical Angles | |
| **Assessment Evidence** | |
| **Performance Tasks:**<br>**T12**: I can identify my objectives and apply the best resources to my learning.<br>**DE4**: I can be respectful and responsible and build positive relationships with all members of the school community.<br><br>End of Unit Assessment<br>● Finding missing angles and side lengths of congruent polygons<br>● Finding an unknown angle formed by intersecting lines<br>● Understanding properties of dilations (lines, circles, angles)<br>● Identifying which statements about dilations are true<br>● Determining which pairs of triangles are similar based on angle information<br>● Selecting all lines that have a given slope<br>● Determining if a student correctly drew a similar polygon<br>● Finding missing side lengths using similarity<br>● Calculating the slope of a line | **Other Evidence:**<br>CER Responses<br>2.1-2.5 Quiz<br>2.6-2.9 Quiz<br>Exit Tickets analyzing student learning and reflections<br>Check Point Assessments<br>Various Thinking Tasks using Building Thinking Classrooms instructional strategies. |

| | |
|---|---|
| • Determining whether a specific point lies on the line<br>• Drawing two dilations of a polygon using given centers and scale factors<br>• Showing and explaining why the dilated figures are similar<br>• Working with parallel lines and triangle angle relationships<br>• Finding unknown angle measures<br>• Understanding 180° rotations and their effect on triangle congruence<br>• Identifying and justifying congruent angles<br>• Applying knowledge of angle sums in triangles and quadrilaterals | |

**Learning Plan**

| Lesson Focus | Learning Activities | CCSS | Vision of a Learner Attribute |
|---|---|---|---|
| Angle Relationships in Triangles (Unit 1: lesson 14) | Ex;lore angle sums using triangle diagrams and folding | 8.G.A.5 | TI3, P4, CCE1, DE4, P3, TCC2 |
| Angles with Parallel lines and Transversals (Unit 1: lesson 15 and 16) | Use visuals and reasoning to explore angle pliers and informal proof | 8.G.A.5 | TI3, P4, CCE1, DE4, P3, TCC2 |
| 1- 2. Projecting & Scaling | Hands-on with cut-outs and radial/circular grids exploring scale factor | CCSS 8.G.A.1 | TI3, P4, DE4 |
| 3-5. Dilation on Grids and Coordinate Plane | Use square grids & coordinates for dilations | CCSS 8.G.A.1, 8.G.A.3 | TCC2, DE4 |
| 6-9. Exploring Similarity | Compare polygons, define similarity, analyze ratio of sides | CCSS 8.G.A.2, 8.G.A.4, 8.G.A.5 | CCE1, TCC2, CCE3, DE4 |
| 10-12. Slope via Similar Triangles | Use slope triangles to derive slope | CCSS 8.G.A.3, 8.EE.B.6, 8.G.A.4 | TI3, TCC2, DE4, P3 |

**Teacher Resources:**

- Illustrative Mathematics Unit 1 & 2 Teacher Guide: detailed lesson narratives and alignment

- Family-facing video summaries (Vimeo/YouTube) explaining content and vocabulary
- Geometry toolkits: tracing paper, graph paper, ruler, protractor, patty paper (MP5 support)
- Digital tools: Desmos/GeoGebra for modeling dilations and slope triangles
- IXL
- Formative assessment protocols: exit tickets, partner critique, reflection prompts focused on transformations and slope reasoning
- 6–8 VoL Attribute List (for guiding student reflection and integration of soft skills)

## Unit 3 - Volume

### Desired Results - Goals, Transfer, Meaning, Acquisition

**Established Goals:**

**G.GMD.A.3**: Use volume formulas for cylinders, cones, and spheres and understand relationships between their volumes and dimensions.

**Standards for Mathematical Practice**

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

**Vision of A Learner Attributes:** Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

**AA2**: I can identify past successful strategies and apply them independently.

DE4: I can be respectful and responsible and build positive relationships with all members of the school community.

P3: I can receive and provide constructive feedback and understand the need to adjust my goals/learning journey.

**CCE1**: I can contribute to discussions with my peers/teachers about a variety of topics, respecting differing viewpoints, actively listening to others, and responding thoughtfully as I apply new knowledge to my thinking.

CCE3: I can participate in collaborative conversations by actively listening, formulating questions ,making connected comments and providing various types of feedback to my peers.

| **Understandings:** Students will understand that… | **Essential Questions:** |
|---|---|
| • Volumes of cylinders, cones, and spheres change predictably with dimensions and can be modeled as functions<br>• Volume formulas reveal relationships between dimensions: cylinder and prism; cone and cylinder; sphere as dimension scales | • How do measurements of three-dimensional figures change when dimensions change—what is the functional relationship? |
| **Students will know...** | **Students will be able to…** |
| How dimensions affect volumes: $V = \pi r^2 h$, $V = (1/3)\pi r^2 h$, $V = (4/3)\pi r^3$ | Use and compare volume formulas; analyze how volume responds to changes in radius or height. |

**Key Vocabulary:** Volume, Cylinder, Cone, Sphere, Radius, Height, Volume Formulas, Equation

**Assessment Evidence**

| **Performance Tasks:** | **Other Evidence:** |
|---|---|
| **AA2:** I can identify past successful strategies and apply them independently.<br>**CCE1**: Respect differing viewpoints, actively listen to others, and apply new knowledge to thinking.<br><br>Summative Assessment<br>• Recall and write the correct volume formulas for: Cylinder, Cone, and Sphere | Exit Tickets analyzing student learning and reflections<br>Check Point Assessments<br>Various Thinking Tasks using Building Thinking Classrooms instructional strategies. |

| | |
|---|---|
| • Use given dimensions and apply appropriate formulas to: Find the volume of a cylinder, Find the volume of a cone, Find the volume of a sphere<br>• Given the volume of a cylinder, work backwards to find the missing height using algebraic reasoning | |

**Learning Plan**

| Lesson Segment | Learning Activities | CCSS | Vision Traits |
|---|---|---|---|
| Cylinders & Cones | Investigate how volume changes with height and radius; derive volume formulas; represent relationships with functional graphs. | G.GMD.A.3 | CCE1, CCE3, DE4, P3, AA2 |
| Spheres & Scaling | Compare volumes of different solids; examine how volume scales with radius using function concepts. | G.GMD.A.3 | CCE1, CCE3, DE4, P3, AA2 |

**Teacher Resources:**
Illustrative Mathematics Unit 5 Teacher Guide (lesson narratives & standards)

Family-facing video summaries for each section (Inputs & Outputs; Functions; Solid Volumes)

Geometry toolkits: tracing paper, graph paper, rulers, colored pencils, cylinders/prisms for volume exploration

Volume formula reference & derivation aids (visual and symbolic)

Digital modeling tools: Desmos/GeoGebra for exploring linear and volume functions

IXL

Formative assessments and protocols: exit tickets, peer critique

# Unit 4 - Linear Functions, Inequalities, and Systems

## Desired Results - Goals, Transfer, Meaning, Acquisition

**Established Goals:**

**Common Core State Standards** (* indicates a modeling standard. For standards that encompass several different topics/concepts, the bolded part is the focus for this unit. If no bolding, the entire standard pertains to this unit.)

- **A.CED.A.2** Create equations that describe numbers or relationships. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- **A.CED.A.3** Create equations that describe numbers or relationships. 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. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.
- **A.REI.C.5** Prove 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.
- **A.REI.C.6** Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
- **A.REI.D.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).
- **A.REI.D.11** Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
- **A.REI.D.12** Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.
- **A.SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.***F.IF.B.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.*
- **F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
- **F.IF.C.7.A Graph linear** and quadratic **functions and show intercepts**, maxima, and minima.
- **F.IF.C.8** Write a function defined by an expression in different by equivalent forms to reveal and explain different properties of the function.
- **F.LE.A.2 Construct linear** and exponential functions, **given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).**

**Standards for Mathematical Practice**

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

**Vision of A Learner Attributes:** Students will be able to independently use their learning to... ("I can" statements to be demonstrated)

- **TCC3(6-8):** I can combine new information with my own ideas to generate solutions.
- **TCC4(6-8)**: I can apply my learning to new experiences, determine if it works, and adjust in the future.
- **AA1(6-8)**: I can implement different pathways to success and recognize the pros and cons of each
- **CCE4(6-8)**: I can express my thoughts and ideas, both verbally and in writing, in order to defend my perspective. I can do this via essays, performance-based projects, whole group, and/or small group discussions.

**Understandings:** Students will understand that…

- Linear functions describe relationships and quantities with a constant additive rate of change, known as the slope.
- Equations represent relationships between quantities and can be graphed on a coordinate plane.
- The graph of a linear function (a line) represents a set of infinite solutions to a two variable equation.
- The average rate of change describes how a function's output changes over an interval.
- Graphs of functions reveal key features like intercepts and its slope.
- Systems of equations and inequalities can model real-world scenarios involving more than one variable.
- A solution to a system of equations is the point where all equations intersect.
- A solution to a system of inequalities is the region of the coordinate plane that contains the ordered pairs that satisfy all of the inequalities.
- Multiple methods can be used to solve systems, each with its own advantages.

**Essential Questions:**

- How can understanding linear functions and their multiple representations help us model real-world situations, interpret relationships, and problem solve effectively?
- What is a linear function, and how can it be represented using equations, graphs, and tables?
- What is the significance of a linear function's slope and y-intercept in the context of modeling linear applications?
- How do changes in the form of a linear equation affect its graph and the relationship between variables?
- What does it mean for an ordered pair to be a solution to a system?
- How do you determine the most efficient method to solve a system?
- How does the number of solutions of a system connect to its graph?
- How do systems help us solve real-world problems with multiple constraints?

| Students will know… | Students will be able to… |
| --- | --- |
| • Linear functions do not include exponents, variables in the denominator, or variables under radicals.<br>• Linear functions have three accepted forms: slope intercept, standard, and point-slope.<br>• Linear functions can be identified from equations, graphs, and tables.<br>• Slope is a constant rate of change that can be calculated from a graph, table, equation, or two points.<br>• The y-intercept is often referred to as the initial value. It can be identified from an equation or from a graph.<br>• The x-intercept is often referred to as the zero of the function - when the value of the function is zero.<br>• Linear functions can be built from graphs, descriptions, or input-output pairs.<br>• To write the equation of a line, at least one point and the slope are needed.<br>• Parallel and perpendicular lines can be identified and written using slope criteria. Parallel lines have the same slope while perpendicular lines have opposite reciprocal slopes.<br>• Expressions can be substituted in for variables.<br>• The solution to a system of linear equations is the ordered pair which is a solution to each linear equation in the system.<br>• There are multiple methods to solve systems of equations. All methods result in the same solution, but one method may be more efficient.<br>• Some systems have infinitely many solutions (graphically they are the same line) or no solution (graphically it results in parallel lines).<br>• Systems can be used to determine break-even points and to analyze data relative to the break-even point.<br>• An inequality divides the coordinate plane into two half-planes. One side of the boundary line will represent solutions and is shaded to show this.<br>• The solution to a system of inequalities is the overlapping region of these shaded half-planes, known as the feasible region. | • Identify and classify linear functions from graphs, tables, and equations.<br>• Calculate the slope of a line from a graph, table, equation, and/or two points.<br>• Interpret the meaning of intercepts given a situation, equation, or graph.<br>• Graph linear functions using slope-intercept form.<br>• Graph linear functions in standard form by rewriting into slope-intercept form or by finding the intercepts.<br>• Graph linear equations in point-slope form.<br>• Write equations of linear functions given a graph, a context, a point and slope, or two points.<br>• Write equations of parallel and perpendicular lines given a line and a point not on the line.<br>• Solve problems involving parallel and perpendicular lines.<br>• Translate between different representations of linear functions (graph, table, equation).<br>• Solve a system of linear equations using graphing, substitution, and elimination methods.<br>• Determine the most efficient method to solve a system of linear equations.<br>• Solve a system of linear inequalities by graphing.<br>• Algebraically check solutions to a system of linear equations and to a system of linear inequalities.<br>• Determine the number of solutions to a system of linear equations.<br>• Write and solve systems of linear equations and of linear inequalities to model real world problems. |

**Key Vocabulary:** Linear Function, Linear Equation, Slope, Constant Rate of Change, Y-intercept, X-intercept, Slope-Intercept Form, Standard Form, Domain, Range, Function Notation, Coordinate Plane, Origin, Solution, Intercept, system of linear equations, system of linear inequalities, equivalent equation, solution, graphing method, substitution method, elimination (linear combination) method, independent, dependent, infinitely many solutions, no solution, revenue, profit, break even point

**Assessment Evidence**

**Performance Tasks:**
TCC3, TCC4 & AA1

Systems of Linear Equations Assessment

- Identifying what each variable represents in a real-world context.
- Translating cost and quantity descriptions into linear equations.
- Modeling two different scenarios as a system of equations.
- Plotting both equations on the same coordinate plane.
- Labeling axes appropriately.
- Explaining the meaning of the intersection point in context.
- Comparing scenarios to decide optimal choices based on the model.
- Creating equations from budget and capacity constraints.
- Solving for both variables to determine quantities.
- Using substitution to solve a system step-by-step.
- Using elimination/addition to solve a system step-by-step.
- Recognizing different approaches (graphing, substitution, elimination) and their uses.

Systems of Linear Inequalities Assessment

- Representing constraints as inequalities.
- Plotting single inequalities on a coordinate plane.
- Adding additional inequalities to the same graph to show combined constraints.
- Finding ordered pairs that satisfy given inequalities.
- Verifying whether specific points remain solutions when new constraints are added.
- Translating real-world scenarios into a system of inequalities.

**Other Evidence:**
CER Responses
Exit Tickets analyzing student learning and reflections
Check Point Assessments
Various Thinking Tasks using Building Thinking Classrooms instructional strategies.

| | |
|---|---|
| • Determining the solution region that satisfies all inequalities.<br>• Clearly shading or marking the feasible region on the graph.<br>• Defining variables and interpreting them in context. | |

**Learning Plan**

The purpose of this unit is to introduce the connection between graphs and linear equations in two variables given multiple equations. Students will discern the best approach for writing systems of equations and solving based on the information given. Systems of equations then extends to systems of inequalities, where there is a feasible region for the solution set.

- This unit starts with an informal introduction to systems of equations through the amusement park problem. Students create tables, graphs, and equations to model three different membership plans at an amusement park. Students compare these plans and look for break even points.
- Students will solve systems by the graphing method, both by hand and using technology (TI graphing calculator, desmos calculator). Students also solve application problems by graphing.
- Students learn algebraic methods for solving systems of equations. Students solve problems that are stand alone and real world problems by substitution and by elimination.
- Students will learn about special cases - inconsistent and dependent systems of equations.
- Students are introduced to systems of linear inequalities using the donut problem .

The unit will conclude with a summative test on all topics**.**

| Lesson Focus | Learning Activities | CCSS Standards | VoL Attributes |
|---|---|---|---|
| IM U4 Lessons 1: Describing and Graphing Situations | Analyze tables, graphs, and descriptions to determine whether relationships are functions; interpret graphs by identifying inputs and outputs. | Build on 8.F.A.1; Address HSF-IF.A.1, HSF-IF.B.4 | TCC3, TCC4, CCE4 |
| Lessons 2–3: Function Notation & Interpretation | Match verbal descriptions to symbolic function rules; interpret function notation in context; draw connections between notation and graphs. | Address HSF-IF.A.2, HSF-IF.B.4 | TCC3, TCC4 |
| Lessons 4–5: Using Function Notation to Describe Rules | Explore “notice & wonder” tasks with functions; practice expressing rules in | Address HSF-BF.A.1, HSF-IF.A.2; Build on 8.F.A.1 | TCC3, TCC4 |

| | | | |
|---|---|---|---|
| | function notation and comparing symbolic and verbal forms. | | |
| Lessons 6–9: Features of Graphs, Average Rate of Change, Interpreting Graphs, Comparing Graphs | Analyze graphical features; calculate and interpret average rate of change; compare multiple representations side by side. | Build on HSF-IF.B.4 | TCC3, TCC4 & AA1 |
| Lessons 10–11: Domain and Range (Parts 1 & 2) | Determine reasonable domain and range from situations, tables, and graphs; interpret graphical features (gaps, endpoints, etc.) to describe domain and range. | Address HSF-IF.B.4, HSF-IF.B.5 | TCC3, TCC4, CCE4 |
| 12–17: Systems of Linear Equations | Write and graph systems; solve via substitution and elimination; reason about number of solutions. | HSA-REI.C.5, HSA-REI.C.6, HSA-REI.D.10 | TCC3, TCC4, CCE4 |
| 18–20: Linear Inequalities in One Variable | Represent situations with inequalities; solve and graph one-variable inequalities. | HSA-REI.B.3, HSA-REI.B.4 | TCC3, TCC4 |
| 21–23: Linear Inequalities in Two Variables | Graph inequalities in two variables; use technology; represent and interpret solution regions. | HSA-CED.A.3, HSA-REI.D.12 | TCC3, TCC4 |
| 24–26: Systems of Linear Inequalities in Two Variables | Model real-world situations using systems of inequalities; interpret feasible regions. | HSA-REI.D.12, HSA-CED.A.3 | TCC3, TCC4 & AA1 |
| | | | |

**Teacher Resources:** IM Algebra 1 Unit 2: Linear Equations, Inequalities, and Systems; State of CT Algebra 1 Model Curriculum Unit 6; Teacher created worksheets and assessments; Desmos; Khan academy; IXL; Socrative; Blooket; Quizizz; Kahoot

## Unit 5 - Pythagorean Theorem and Irrational Numbers

| Desired Results - Goals, Transfer, Meaning, Acquisition | |
|---|---|
| **Established Goals:**<br><br>● **8.G.B.6: Understand and use the Pythagorean Theorem to determine unknown side lengths in right triangles in contextual and coordinate settings.**<br>● **8.NS.A.2: Use rational approximations of irrational numbers to locate and compare them on the number line.**<br>● **8.EE.A.2: Perform arithmetic with numbers expressed in scientific notation, including operations with very large or very small values (supports understanding of irrational decimal representations)**<br><br>**Standards for Mathematical Practice**<br>● MP1: Make sense of problems and persevere in solving them.<br>● MP2: Reason abstractly and quantitatively.<br>● MP3: Construct viable arguments and critique the reasoning of others.<br>● MP4: Model with mathematics.<br>● MP5: Use appropriate tools strategically.<br>● MP6: Attend to precision.<br>● MP7: Look for and make use of structure.<br>● MP8: Look for and express regularity in repeated reasoning. | |
| **Vision of A Learner Attributes:** Students will be able to independently use their learning to... (“I can” statements to be demonstrated)<br><br>● **TCC2**: I can evaluate data gathered from multiple perspectives and draw conclusions.<br>● **TCC4**: I can apply my learning to new experiences, determine if it works and adjust in the future.<br>● DE4: I can be respectful and responsible and build positive relationships with all members of the school community.<br>● P3: I can receive and provide constructive feedback and understand the need to adjust my goals/learning journey.<br>● CCE3: I can participate in collaborative conversations by actively listening, formulating questions ,making connected comments and providing various types of feedback to my peers. | |
| **Understandings:** Students will understand that…<br><br>● Proofs of the Pythagorean Theorem can be constructed both algebraically and geometrically by showing area equivalence.<br>● The set of real numbers includes irrational numbers (like $\sqrt{2}$) that cannot be expressed exactly as fractions or decimals.<br>● Square roots and cube roots represent side or edge lengths in geometric contexts and often require irrational approximations. | **Essential Questions:**<br><br>● Why does $a^2 + b^2 = c^2$ for every right triangle?<br>● What differentiates rational from irrational numbers, and how can we estimate irrational values?<br>● How can we use the Pythagorean Theorem across dimensions and coordinate systems? |

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| • The Pythagorean Theorem extends to coordinate geometry and three-dimensional right rectangular prisms. | |
| **Students will know...**<br><br>• Definitions: rational vs. irrational numbers; square root and cube root notation.<br>• Two proofs of the Pythagorean Theorem—using algebraic argument and area decomposition.<br>• How to use the Pythagorean Theorem in problem-solving across two and three dimensions. | **Students will be able to...**<br><br>• Apply the Pythagorean Theorem to compute distances in right triangles (including 3D prism diagonals).<br>• Justify the theorem using area-based reasoning or algebraic manipulation.<br>• Classify and approximate irrational numbers (e.g., $\sqrt{10}$ , $\sqrt{2}$, $\sqrt[3]{30}$) on the number line.<br>• Approximate irrational results in context and compare their magnitudes relative to rational benchmarks. |
| **Key Vocabulary:** Pythagorean Theorem, hypotenuse, leg, square root, cube root, irrational number, rational number, approximate, square of a number, proof, coordinate distance, prism diagonal. | |
| **Assessment Evidence** | |
| **Performance Tasks:**<br>**TCC2**: Evaluate data gathered from multiple perspectives and draw conclusions.<br>**TCC4**: I can apply my learning to new experiences, determine if it works and adjust in the future.<br><br>Summative Assessment<br><br>• Calculate area given the side lengths of squares in different units (inches, units, cm).<br>• Determine the side length of a square when given the area in various units.<br>• Classify numbers as rational or irrational.<br>• Identify two whole numbers between which a square root falls | **Other Evidence:**<br>Various Thinking Tasks using Building Thinking Classrooms instructional strategies.<br>Exit Tickets analyzing student learning and reflections<br>Check Point Assessments |

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| • Write the Pythagorean Theorem correctly.<br>• Use the Pythagorean Theorem to find missing side lengths in right triangles<br>• Apply the Pythagorean Theorem in a real-world context | |

**Learning Plan**

| Lessons | Activities | Standards | Vision Attributes |
|---|---|---|---|
| Square Area vs. Side Length | Explore area decomposition of tilted squares; introduce $\sqrt{n}$ | 8.NS.A.2 | TCC2, DE4, CCE3 |
| Number Line Placement of Roots | Sequence $\sqrt{n}$ and $\sqrt[3]{n}$ using bounds; plot on number line | 8.NS.A.2 | TCC2, DE4, CCE3 |
| Pythagorean Proofs | Conduct two Pythagorean Theorem proofs (algebraic and geometric) | 8.G.B.6 | DE4, CCE3 |
| Applying the Theorem | Solve right triangle and coordinate distance problems | 8.G.B.6 | DE4, CCE3 |
| Cube Roots & 3D Diagonals | Relate cube roots to volumes; explore 3D prism diagonals | 8.NS.A.2, 8.G.B.6 | TCC2, DE4, CCE3, P3 |
| Decimal Representations & Irrationality | Explore decimal representations and irrational numbers (e.g., $\sqrt{2}$) | 8.NS.A.2 | DE4, CCE3, P3 |
| Culminating – Real-World Problems | Apply Pythagorean and irrational approximations in real-world contexts | All | TCC2, DE4, CCE3, P3 |

**Teacher Resources:**

- Illustrative Mathematics Unit 8 Teacher Guide with lesson narratives & standards
- Family-Friendly Unit Videos on square roots, Pythagorean proofs, and approximations

- Geometric tools: square/rectangle manipulatives, draft paper for area proof activities
- Graph paper & calculators for plotting and distance computations
- IXL
- Formative assessments: exit tickets on plotting roots and approximation justification
- Proof scaffolds: graphic organizers for algebraic and geometric theorem proofs

# Unit 6 - Introduction to Statistics

## Desired Results - Goals, Transfer, Meaning, Acquisition

**Established Goals:**

**Common Core State Standards** (* indicates a modeling standard. For standards that encompass several different topics/concepts, the bolded part is the focus for this unit. If no bolding, the entire standard pertains to this unit.)

- **S.ID.A.1** Represent data with plots on the real number line (dot plots, histograms, and box plots).
- **S.ID.A.2** Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
- **S.ID.A.3** Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
- **S.ID.B.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.
- **S.ID.B.6** Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
    - **S.ID.B.6.A Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear,** quadratic, and exponential models.
    - **S.ID.B.6.C** Fit a linear function for a scatter plot that suggests a linear association.
- **S.ID.C.7** Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
- **S.ID.C.8** Compute (using technology) and interpret the correlation coefficient of a linear fit.

**Standards for Mathematical Practice**

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

**Vision of A Learner Attributes:** Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- TCC3: I can combine new information with my own ideas to generate solutions
- DE3: I can identify my emotions and manage reactions using appropriate strategies and seek support when needed.
- TI4(6-8): I can identify my strengths and areas for growth, set goals toward improvement, and seek support as needed.

| | |
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| **Understandings:** Students will understand that...<br>● Data can be represented in multiple graphical ways to reveal trends and insights.<br>● Measures of center and spread can be used to summarize quantitative data.<br>● The context of data matters when interpreting statistical findings.<br>● Bivariate data can be analyzed using scatterplots and equations of the line of best fit. | **Essential Questions:**<br>● How can data be represented and interpreted to make real-wold decisions?<br>● What can measures of center and spread tell us about a data set?<br>● How do outliers and distribution shape influence interpretation of data?<br>● How can the equation of a trend line be used to make predictions about bivariate data? |
| **Students will know...**<br>● Data involving one quantitative variable can be displayed and analyzed using dot plots, histograms, and box plots.<br>● Mean and median are used to describe and compare the center of a distribution; interquartile range (IQR) and standard deviation are used to describe and compare the spread of a distribution.<br>● Data involving two categorical variables can be displayed and analyzed using two way tables.<br>● Data involving two quantitative variables can be displayed and analyzed using scatterplots. | **Students will be able to...**<br>● Create and analyze dot plots.<br>● Create and analyze histograms.<br>● Calculate the mean, median, mode, range, and IQR.<br>● Use technology to calculate the five-number summary and the standard deviation.<br>● Interpret the standard deviation and compare the standard deviation between two data sets.<br>● Create and analyze box plots.<br>● Interpret the skewness of data.<br>● Use a two-way table to describe categorical data<br>● Create a scatterplot to display quantitative data<br>● Describe a scatterplot in terms of direction and strength<br>● Sketch a line of best fit for a scatterplot<br>● Use technology to calculate the equation of the line of best fit and to calculate the correlation coefficient<br>● Use the equation of the line of best fit to make predictions about the data set |
| **Key Vocabulary:** Box Plot, Dot Plot, Histogram, Interquartile Range, Mean, Median, Mode, Outlier, Range, Skewed Left, Skewed Right, Skewness, Standard Deviation, Two way table, Scatterplot, Direction, Strength, Correlation | |
| **Assessment Evidence** | |
| **Performance Tasks:** | **Other Evidence:** |

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|---|---|
| TCC3, DE3, TI4<br><br>End of Unit Assessment<br><br>● Determining percentages from a given range of values.<br>● Calculating and interpreting the interquartile range (IQR).<br>● Finding and explaining the meaning of the median.<br>● Explaining when and why the mean can or cannot be determined from a box plot<br>● Comparing standard deviations between two data sets based on spread.<br>● Comparing standard deviations between groups and explaining reasoning without calculations.<br>● Identifying when mean and median are equal from a graph.<br>● Determining which data set has a greater standard deviation without computation.<br>● Finding the mode(s) from a graph.<br>● Predicting how adding an extreme value would affect the mean.<br>● Recognizing shapes of distributions (e.g., skewed, symmetric, bimodal, uniform, bell-shaped).<br>● Using a scientific calculator to compute mean, standard deviation, and the 5-number summary.<br>● Creating a box plot from given data.<br>● Explaining how removing an outlier affects the mean and standard deviation | Various Thinking Tasks using Building Thinking Classrooms instructional strategies.<br>Exit Tickets analyzing student learning and reflections<br>Check Point Assessments |

**Learning Plan**

This unit is designed to have students learn how to summarize data, both graphically and through statistics.

- Students study one variable quantitative data. Students create and analyze dot plots, histograms, and boxplots. They discuss the shape of these graphs, focusing on symmetry and skewness.
- Students use one variable statistics to summarize data. They calculate mean, median, mode, range, the 5 number summary, and the interquartile range (IQR) by hand, before learning how to calculate these using technology (graphing calculator and desmos calculator). Students use technology to calculate the standard deviation.
- Students look at two variable categorical data, which is summarized in two way tables. They create tables based on data, and they describe the data by calculating relative frequencies.

- Students study two variable quantitative data by creating and describing scatterplots. They use technology (graphing calculator and desmos calculator) to determine the equation of the line of best fit and to calculate the correlation coefficient. They interpret the slope and y-intercept of the trend line and use the trend line to make predictions about the data.

| Lesson Focus | Learning Activities | CCSS Standards | VoL Attributes |
|---|---|---|---|
| Getting to Know You; Data Representations (1–2) | Introduce statistical vs. non-statistical questions; represent data with dot plots, histograms, box plots; calculate five-number summary; interpret displays. | Builds on 6.SP.B.4; Addresses HSS-ID.A.1; Builds toward HSS-ID.A.2 | TCC3, DE3 |
| A Gallery of Data; Distribution Shapes (3–5) | Create and analyze data displays; describe distribution shapes using correct terminology. | Addresses HSS-ID.A.1, HSS-ID.A.2; Builds toward HSS-ID.A.3 | TCC3 |
| Describing Distributions with Numbers (6) | Calculate measures of center (mean, median) and variability (range, IQR, MAD) from data sets; connect numerical measures to data displays. | HSS-ID.A.1, HSS-ID.A.2 | TCC3 |
| The Mean as a Balance Point (7) | Use dot plots to visualize mean as balance point; explore how data changes affect mean. | HSS-ID.A.2 | TCC3 |
| The Median as a Middle (8) | Identify median from data sets and graphs; explore resistance to extreme values; compare to mean. | HSS-ID.A.2 | TCC3 |
| Choosing a Summary Statistic (9) | Decide whether mean or median is more appropriate based on distribution shape and context. | HSS-ID.A.2, HSS-ID.A.3 | TCC3, DE3 |
| The Effect of Extremes (10) | Examine how extreme values affect mean and median; use dot plots to investigate distribution shape and measures of center. | HSS-ID.A.1, HSS-ID.A.2, HSS-ID.A.3 | TCC3 |
| Comparing & Contrasting Data | Compare variability using measures | HSS-ID.A.1, HSS-ID.A.2, HSS-ID.A.3 | TCC3, DE3, TI4 |

| | | | |
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| Distributions (11) | like MAD and IQR; connect terminology, data displays, measures of center and variability. | | |
| Measuring Variability with MAD (12) | Calculate Mean Absolute Deviation; interpret its meaning; compare to IQR. | HSS-ID.A.2, HSS-ID.A.3 | TCC3 |
| Measuring Variability with IQR (13) | Calculate Interquartile Range; compare to MAD in representing spread. | HSS-ID.A.2, HSS-ID.A.3 | TCC3 |
| Variability and Outliers (14) | Determine outliers using IQR; discuss effects on measures of center and spread. | HSS-ID.A.2, HSS-ID.A.3 | TCC3, DE3 |
| Summarizing Data Distributions (15) | Synthesize understanding of center, variability, and shape to describe data distributions comprehensively. | HSS-ID.A.1, HSS-ID.A.2, HSS-ID.A.3 | TCC3 |

**Teacher Resources:** Algebra 1 Textbooks; IM Algebra 1 Unit 1: One-Variable Statistics; IM Algebra 1 Unit 3: Two-Variable Statistics; State of CT Algebra 1 Model Curriculum Unit 5; Desmos; TI Smartview Software; Teacher created in-class notes, activities, and problem sets; Desmos; Khan academy; IXL; Socrative; Blooket; Quizizz; Kahoot

# Unit 7 - Exponents and Scientific Notation

## Desired Results - Goals, Transfer, Meaning, Acquisition

**Established Goals:**

**8.EE.A.1**: Know and apply the properties of integer exponents to generate equivalent expressions (product, power of a power, quotient, zero, negative exponents)

**8.EE.A.2**: Use scientific notation to express very large or very small numbers and perform operations with numbers written in scientific notation.

**8.EE.A.3** Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other.

**8.EE.A.4** Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used.

**Standards for Mathematical Practice**

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

**Vision of A Learner Attributes:** Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

DE4: I can be respectful and responsible and build positive relationships with all members of the school community.

**P3**: I can receive and provide constructive feedback and understand the need to adjust my goals/learning journey.

| | |
|---|---|
| **CCE3**: I can participate in collaborative conversations by actively listening, formulating questions ,making connected comments and providing various types of feedback to my peers. | |
| **Understandings:** Students will understand that…<br><br>Exponent rules (e.g. $x^a \bullet x^b = x^{a+b}$ ; $(x^a)^b = x^{a \bullet b}$; $x^0 = 1$; $x^{-1} = 1/x^1$ allow systematic manipulation of exponential expressions.<br><br>Negative and zero exponents naturally extend exponent concepts to include division and reciprocal relationships.<br><br>Scientific notation is a compact form using powers of ten that makes it easier to work with very large/small numbers, both conceptually and computationally. | **Essential Questions:**<br>How do exponent rules help us simplify expressions and solve problems?<br><br>Why do negative and zero exponents make sense in terms of repeated multiplication/division?<br><br>When and why is scientific notation useful for representing extremely large or small numbers? |
| **Students will know…**<br><br>Definitions of exponents (integer), exponent rules (product, power of a power, quotient, zero, negative), and scientific notation.<br><br>When and how to apply exponent rules to rewrite expressions.<br><br>How scientific notation expresses magnitude and supports calculations with large/small numbers. | **Students will be able to...**<br><br>Apply exponent properties to simplify and rewrite expressions.<br><br>Interpret and simplify expressions with zero and negative exponents.<br><br>Convert numbers into and from scientific notation.<br><br>Multiply and divide in scientific notation; estimate using order of magnitude. |
| **Key Vocabulary:** Exponent, base, product rule, power of a power, quotient rule, zero exponent, negative exponent, scientific notation, order of magnitude, coefficient. | |
| **Assessment Evidence** | |
| **Performance Tasks:**<br>**P3**: I can receive and provide constructive feedback and understand | **Other Evidence:**<br>Various Thinking Tasks using Building Thinking Classrooms |

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|---|---|
| the need to adjust my goals/learning journey.<br><br>**CCE3**: I can participate in collaborative conversations by actively listening, formulating questions ,making connected comments and providing various types of feedback to my peers.<br><br>Summative Assessment<br><br>● Evaluate numeric expressions with positive and negative exponents<br>● Demonstrate understanding of exponent meaning (e.g., $3^3$, $5^{-3}$)<br>● Simplify expressions using properties of exponents:, Product of powers, Power of a power, Negative exponents<br>● Writing as a single expression with a positive exponent only<br>● Convert standard form numbers (very large and very small) into scientific notation<br>● Apply correct format (significant figure × $10^{exponent}$)<br>● Convert from scientific notation into standard decimal form<br>● Demonstrate understanding of powers of 10 and decimal placement | instructional strategies.<br>Exit Tickets analyzing student learning and reflections<br>Check Point Assessments |

**Learning Plan**

| Lesson(s) | Learning Activities | Standards | Vision Traits |
|---|---|---|---|
| Exponent Review | Review whole-number exponents; connect repeated division to negative exponents | 8.EE.A.1 | DE4, CCE3 |
| Exponent Rules | Explore product, power-of-power, quotient rules through tables & pattern reasoning | 8.EE.A.1 | DE4, P3, CCE3 |
| Zero & Negative Exponents | Reason through division patterns to understand $x^0$ and $x^{-n}$; apply to rational bases | 8.EE.A.1 | DE4, CCE3 |

| | | | |
|---|---|---|---|
| Powers of Ten | Multiply/divide large powers of ten; understand orders of magnitude | 8.EE.A.1 | DE4, P3, CCE3 |
| Scientific Notation Intro | Convert numbers to/from scientific notation; place on number lines | 8.EE.A.2 | DE4, CCE3 |
| Operations in Sci. Notation | Practice multiplying/dividing scientific notation with estimation challenges | 8.EE.A.2, 8.EE.A.3 , 8.EE.A.4 | DE4, P3, CCE3 |

**Teacher Resources:**

Illustrative Mathematics Unit 7 Teacher Guide (lesson narratives and pedagogy)

Family-facing video summaries introducing exponent rules and scientific notation Student tools: calculators, exponent rule charts, scientific notation reference sheets

IXL
Formative tools: exit tickets on exponent simplification, mini-quizzes on notation conversion
Visual aids: exponent laws posters and order-of-magnitude number line visuals

# Unit 8 - Exponential Functions

## Desired Results - Goals, Transfer, Meaning, Acquisition

**Established Goals:**

**Common Core State Standards** (* indicates a modeling standard. For standards that encompass several different topics/concepts, the bolded part is the focus for this unit. If no bolding, the entire standard pertains to this unit.)

- **8.EE.A.1** Know and apply the properties of integer exponents to generate equivalent numerical expressions. *For example, 3^2 times 3^(-5) = 3^(-3) = 1/3^3 = 1/27.*
- **N.RN.A.1** Explain how the definition of the meaning of a rational exponent follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. *For example, we define 5^(1/3) to be the cube root of 5 because we want [5^(1/3)]^3 = 5^[(1/3) x 3] to hold, so [5^(1/3)]^3 must equal 5.*
- **N.RN.A.2** Rewrite expressions involving radicals and rational exponents using the properties of exponents.
- **F.IF.B.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. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.* (For this unit, we will be discussing finding the asymptote and y-intercept).*
- **F.IF.B.5** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.**
- **F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand and in simple cases using technology for more complicated cases.*
    - **F.IF.C.7.E Graph exponential** and logarithmic **functions, showing intercepts** and end behavior, and trigonometric functions, showing period, midline, and amplitude.
- **F.IF.C.8** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
    - **F.I.C.8.B** Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as y = (1.02)^t, y = (0.97)^t, y = (1.01)^(12t), y = (1.2)^(t/10), and classify them as representing exponential growth and decay.*
- **F.IF.C.9** Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*
- **F.BF.A.1** Write a function that describes a relationship between two quantities.*

- **F.LE.A.1** Distinguish between situations that can be modeled with linear functions and with exponential functions.
    - **F.LE.A.1.A** Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.
    - **F.LE.A.1.B** Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
    - **F.LE.A.1.C** Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
- **F.LE.A.2 Construct** linear and **exponential functions,** including arithmetic and **given graph, a description of a relationship, or two input-output pairs (including reading these from a table).**
- **F.LE.A.3** Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantitative increase linearly, quadratically, or (more generally) as a polynomial function.
- **F.LE.B.5** Interpret the parameters in a linear or exponential function in terms of a context.
- **A.REI.D.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).
- **A.CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- **S.ID.B.6.A** Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

**Standards for Mathematical Practice**

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

**Vision of A Learner Attributes:** Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- **TCC3(6-8)**: I can combine new information with my own ideas to generate solutions.
- **TI3(6-8)**: I can compose specific questions that are relevant to a task to support my learning
- **CCE4(6-8)**: I can express my thoughts and ideas, both verbally and in writing, in order to defend my perspective. I can do this via essays, performance-based projects, whole group, and/or small group discussions.

| **Understandings:** Students will understand that... | **Essential Questions:** |
|---|---|
| ● Exponential functions represent relationships involving a constant multiplicative rate of change.<br>● Exponential functions represent relationships involving rapid | ● How are exponential properties related to observed patterns?<br>● What are the characteristics of exponential growth and decay and how is this reflected in real-world phenomena? |

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| growth or decay and can model real-world situations involving finance, medicine, and populations.<br>● Exponential and linear models both involve a constant rate of change. Exponential models are a multiplicative rate of change while linear models are an additive rate of change. | ● How can you differentiate between an exponential model and a linear model? |
| **Students will know...**<br>● The properties of exponents are specific rules derived from observed patterns in mathematics. These include the product, quotient, and power rules, as well as the zero exponent and negative exponent rules.<br>● Rational exponents allow you to convert expressions to simplify.<br>● Radical expressions can be simplified by removing any perfect-square factors.<br>● Exponential functions change by a constant factor.<br>● Simple and compound interest is an exponential growth model.<br>● Depreciation and half-life are exponential decay models.<br>● Interest can compound in different time intervals.<br>● The graphs of exponential functions include a horizontal asymptote. | **Students will be able to...**<br>● Simplify expressions using properties of exponents, including integer and rational exponents.<br>● Convert between radicals and rational exponents to simplify expressions.<br>● Simplify radical expressions.<br>● Distinguish between exponential and linear models given graphs, tables, and equations.<br>● Determine the growth/decay rate of an exponential model from tables, graphs, equations, or application problems.<br>● Represent exponential functions graphically or as equations, including situations involving growth, decay, and compound interest.<br>● Model exponential equations from situations involving growth and decay, such as student loan interest or half-life.<br>● Use technology to model and evaluate exponential relations to solve problems.<br>● Graph exponential functions; identify the y-intercept and asymptote. |
| **Key Vocabulary:** Appreciation, Base, Compound Interest, Cube Root, Decay, Decay Factor, Depreciation, Exponent, Exponential Function, Growth, Growth Factor, Initial Value, Integer Exponents, Negative Exponent, Power, Power Rule, Product Rule, Quotient Rule, Radical, Rational Exponent, Square Root | |
| **Assessment Evidence** | |
| **Performance Tasks:**<br>TCC3(6-8), TI3(6-8), & CCE4(6-8)<br>Exponentials Assessment<br>● Ability to recall and write the general equation for exponential growth and identify what each variable represents. | **Other Evidence:** |

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| • Ability to recall and write the general equation for exponential decay and identify what each variable represents.<br>• Determining whether a scenario represents exponential growth or decay and explaining the reasoning.<br>• Identifying the initial value from a real-world context.<br>• Identifying the growth or decay rate from a real-world context.<br>• Determining the growth or decay factor from the given rate.<br>• Writing an equation to model a real-world exponential growth or decay situation.<br>• Using the model to calculate the value after a specified number of years. | |

**Learning Plan**

In this unit, students will explore the properties of exponents and exponential functions, including their applications to everyday life. Students will distinguish between linear functions and exponential functions. This is also the first function in which students are exposed to the idea of an asymptote, a line that the graph approaches, and functions with range restrictions.

- Students will investigate the properties of exponents and simplify expressions using the properties of exponents.
- Students will extend the properties of exponents to rational exponents and convert between rational exponents and radical expressions.
- Students will compare linear and exponential models.
- Students will construct exponential functions to model growth and decay using simple and compound interest. This will include examples of tax, loans, car value, and population modeling.
- Students will graph exponential functions including their key features of the horizontal asymptote, y-intercept, and 1-2 other points.

| Lesson Focus | Learning Activities | CCSS Standards | VoL Attributes |
|---|---|---|---|
| Lesson 1: Introducing Exponential Growth | Explore contexts that exhibit multiplicative change; compare linear and exponential growth using tables and graphs. | HSF-LE.A.1, HSF-LE.A.2 | TCC3, CCE4 |
| Lesson 2: Representing Exponential Growth with Equations | Write equations to represent exponential growth situations; interpret parameters in context. | HSF-LE.A.2, HSF-LE.B.5 | TI3, CCE4 |
| Lesson 3: Connecting Equations and Graphs of Exponential Functions | Graph exponential functions from equations; identify initial value and | HSF-LE.A.2, HSF-IF.C.7e | TCC3, TI3 |

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| | growth factor. | | |
| Lesson 4: Interpreting Parameters of Exponential Functions | Interpret the meaning of parameters in exponential equations in real-world contexts. | HSF-LE.B.5, HSF-IF.B.4 | CCE4 |
| Lesson 5: Introducing Exponential Decay | Model situations with exponential decay; distinguish between growth and decay contexts. | HSF-LE.A.1, HSF-LE.A.2 | CCE4, TCC3 |
| Lesson 6: Comparing Linear and Exponential Models | Compare outputs of linear and exponential models; discuss differences in long-term behavior. | HSF-LE.A.1, HSF-LE.A.3 | TCC3, TI3 |
| Lesson 7: Graphing Exponential Decay Functions | Graph exponential decay functions; connect features of the graph to the equation. | HSF-LE.A.2, HSF-IF.C.7e | TCC3, CCE4 |
| Lesson 8: The Role of the Base in Exponential Functions | Explore how different base values affect the shape and steepness of exponential graphs. | HSF-LE.A.2, HSF-IF.C.7e | CCE4, TCC3, TI3 |
| Lesson 9: Transformations of Exponential Functions | Apply vertical and horizontal shifts, reflections, and stretches to exponential graphs. | HSF-BF.B.3, HSF-IF.C.7e | TCC3 |
| Lesson 10: Interpreting Exponential Models | Interpret and compare exponential models given in different forms (graphical, tabular, equation). | HSF-LE.A.2, HSF-LE.B.5 | TCC3, TI3 |
| Lesson 11: Continuous Growth and Decay | Explore continuously compounding growth and decay models; interpret the constant rate. | HSF-LE.A.1, HSF-LE.A.4 | TCC3, TI4, CCE4 |
| Lesson 12: Choosing Linear, Quadratic, or Exponential Models | Analyze situations and choose the best-fitting model type; justify reasoning. | HSF-LE.A.1, HSF-LE.A.3 | TCC3, TI4, CCE4 |
| Lesson 13: Review of Exponential Functions | Review major concepts of the unit through problem-solving and discussion. | HSF-LE.A.1, HSF-LE.A.2, HSF-LE.A.4, HSF-LE.B.5 | CCE4, TCC3, TI3 |

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| Unit Assessment | Assess understanding of exponential and logarithmic functions and their applications. | HSF-LE.A.1, HSF-LE.A.2, HSF-LE.A.4, HSF-LE.B.5 | CCE4, TCC3, TI3 |

**Teacher Resources:** Algebra 1 Textbooks; IM Algebra 1 Unit 5: Introduction to Exponential Functions; State of CT Algebra 1 Model Curriculum Unit 7; Desmos; TI Smartview Software; Teacher created in-class notes, activities, and problem sets

# Unit 9 - Operations with Polynomial Expressions

## Desired Results - Goals, Transfer, Meaning, Acquisition

**Established Goals:**

**Common Core State Standards** (* indicates a modeling standard. For standards that encompass several different topics/concepts, the bolded part is the focus for this unit. If no bolding, the entire standard pertains to this unit.)

- **A.SSE.A.1** Interpret expressions that represent a quantity in terms of its context.*
  - **A.SSE.A.1.A** Interpret parts of an expression, such as terms, factors, and coefficients.
- **A.SSE.A.2** Use the structure of an expression to identify ways to rewrite it. For example, see x^4 – y^4 as (x^2)^2 – (y^2)^2, thus recognizing it as a difference of squares that can be factored as (x^2 – y^2)(x^2 + y^2).
- **A.SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*
  - **A.SSE.B.3.A** Factor a quadratic expression to reveal the zeros of the function it defines.
  - **A.SSE.B.3.B** Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
- **A.APR.A.1** Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.
- **A.APR.B.3** Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.
- **F.IF.C.8** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
  - **F.IF.C.8.A** 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.

**Standards for Mathematical Practice**

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

**Vision of A Learner Attributes:** Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- **TCC2(6-8):** I can evaluate data gathered from multiple perspectives and draw conclusions

- **CCE4(6-8):** I can express my thoughts and ideas, both verbally and in writing, in order to defend my perspective. I can do this via essays, performance-based projects, whole group, and/or small group discussions.
- **DE1 (6-8)**: I can search for multiple perspectives and compare and contrast those perspectives

**Understandings:** Students will understand that...

- Polynomial expressions can be simplified and factored using different strategies.
- Operations on polynomials follow similar rules to operations on integers.
- Factoring allows us to identify important features such as zeros of a function.

**Essential Questions:**

- How can polynomials be classified and simplified?
- What is the difference between a constant, linear, quadratic, and cubic polynomial?
- How do operations on polynomials reflect operations on numbers?
- How can you verify two algebraic expressions that appear to be different are equivalent?
- How do you determine which strategy to use when factoring polynomial expressions?

**Students will know...**

- Polynomials are classified by the degree and number of terms (Monomial, Binomial, Trinomial, Polynomial, Constant, Linear, Quadratic, Cubic, Quartic, Quintic).
- Distribution is an extension of the properties of exponents and multiplication.
- Like terms mean the same variable and the same degree.
- Standard form is the highest degree term to the lowest degree.
- Factoring is the inverse of a product.
- The mathematical rules for adding, subtracting, and multiplying polynomials.
- Various methods of factoring including GCF, grouping, difference of squares, and trinomials.

**Students will be able to…**

- Classify a polynomial by its degree and number of terms.
- Simplify/Perform the operations of adding, subtracting, and multiplying on polynomial expressions.
- Write a polynomial expression in standard form.
- Factor the GCF from a polynomial expression.
- Factor trinomials, binomials (difference of squares), and polynomials with 4 terms (grouping).
- Recognize that the sum of two squares cannot be factored under the real numbers.

**Key Vocabulary:** polynomial, degree, term, monomial, binomial, trinomial, constant, linear, quadratic, cubic, quartic, quintic, factor, GCF (greatest common factor), grouping, distributive property, like terms, factor completely, perfect square trinomials, standard form

**Assessment Evidence**

| **Performance Tasks:** | **Other Evidence:** |
|---|---|
| **Summative Assessment: Test Unit 7 TCC2(6-8); CCE4(6-8)** Topics will include:<br>• Classifying polynomial expressions<br>• Simplify polynomial expressions and rewrite in standard form<br>• Multiply polynomial expressions<br>• Factor polynomial expressions including GCF, difference of two squares, a=1, and a>1 (if time permits). | Common Formative/Interim Assessments:<br>• Vocabulary, adding and subtracting polynomials<br>• Multiplying polynomials<br>• Factoring the GCF<br>• Factoring trinomials when a=1,<br>• Factoring a difference of squares<br>• Factoring polynomial expressions by grouping |

**Learning Plan**

This unit begins with students developing an understanding of what it means to be a polynomial. Examples and non-examples are compared to arrive at a definition. Students will classify polynomials by their degree and number of terms. Students learn to add, subtract, and multiply polynomials. Students learn how to factor the greatest common factor from a polynomial, and how to factor a trinomial into two binomials.Students learn to factor binomials when they are a difference of squares. Finally, students will use factoring by grouping to factor polynomials with 4 terms.

| Lesson Focus | Learning Activities | CCSS Standards | VoL Attributes |
|---|---|---|---|
| Lesson 1: Introducing Polynomial Expressions | Explore addition, subtraction, and multiplication of polynomial expressions in context. | HSA-APR.A.1, HSA-SSE.A.1 | TCC2, CCE4, |
| Lesson 2: Structure of Polynomial Expressions | Interpret structure of polynomials and identify terms, degree, and leading coefficients. | HSA-SSE.A.1, HSA-SSE.A.2 | CCE4 |
| Lesson 3: Adding and Subtracting Polynomials | Combine like terms and simplify polynomial expressions; interpret results in context. | HSA-APR.A.1 | TCC2, CCE4, DE1 |
| Lesson 4: Multiplying Polynomials | Multiply binomials and larger polynomials; connect to area models and algebraic representations. | HSA-APR.A.1 | TCC2, CCE4, DE1 |
| Lesson 5: Special Products of Polynomials | Recognize and apply patterns such as (a+b)^2, (a-b)^2, and (a+b)(a-b). | HSA-APR.A.1, HSA-SSE.A.2 | TCC2 |

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| Lesson 6: Factoring Quadratic Expressions | Factor quadratic expressions to reveal zeros of the function. | HSA-SSE.B.2, HSA-SSE.B.3a | TCC2, CCE4 |
| Lesson 7: Factoring Special Polynomial Forms | Factor special products such as difference of squares, perfect square trinomials, and sum/difference of cubes. | HSA-SSE.B.2, HSA-SSE.B.3a | TCC2, CCE4, DE1 |
| Unit Assessment | Assess understanding of polynomial expressions, functions, and applications. | HSA-APR.A.1, HSA-APR.B.2, HSA-APR.B.3, HSF-IF.C.7c | TCC2, CCE4 |

**Teacher Resources:** Algebra 1 Textbooks; IM Algebra 2 Unit 2: Polynomials and Rational Functions (lessons 1-4); State of CT Algebra 1 Model Curriculum Unit 8; Teacher created worksheets and assessments; Desmos; Khan academy; IXL; Socrative; Blooket; Quizizz; Kahoot

# Unit 10 - Introduction to Quadratic Functions

## Desired Results - Goals, Transfer, Meaning, Acquisition

**Established Goals:**

**Common Core State Standards** (* indicates a modeling standard. For standards that encompass several different topics/concepts, the bolded part is the focus for this unit. If no bolding, the entire standard pertains to this unit.)

- **A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems.** *Include equations arising from linear and **quadratic functions**, and simple rational and exponential functions.*
- **A.CED.A.2** Create equations that describe numbers or relationships. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- **A.REI.A.1** Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
- **A.REI.B.4** Solve quadratic equations in one variable.
    - **A.REI.B.4.B** Solve quadratic equations by inspection (e.g., for x^2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.
- **F.IF.B.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. *Key features include: intercepts;** intervals where the function is increasing, decreasing, positive, or negative; **relative maximums and minimums; symmetries; end behavior**; and periodicity.**
- **F.IF.B.5** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*
- **F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
    - **F.IF.C.7.A** Graph linear and quadratic functions and show intercepts, maxima, and minima.*
- **F.IF.C.9** Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*
- **F.BF.A.1** Write a function that describes a relationship between two quantities.*
- **F.BF.B.3** Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k 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. *An exploratory introduction if time permits. This is not assessed in Algebra 1, it will be taught and assessed in Algebra 2.*

- **S.ID.B.6.A** Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
- **N.Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*
- **N.Q.A.2** Define appropriate quantities for the purpose of descriptive modeling.*
- **N.Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

**Standards for Mathematical Practice**

- MP1: Make sense of problems and persevere in solving them.
- MP2: Reason abstractly and quantitatively.
- MP3: Construct viable arguments and critique the reasoning of others.
- MP4: Model with mathematics.
- MP5: Use appropriate tools strategically.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.
- MP8: Look for and express regularity in repeated reasoning.

**Vision of A Learner Attributes:** Students will be able to independently use their learning to... (“I can” statements to be demonstrated)

- **TCC3(6-8):** I can combine new information with my own ideas to generate solutions.
- **AA1(6-8)**: I can implement different pathways to success and recognize the pros and cons of each
- **P1 (6-8)**: I can build a personal tool-box to identify my personal strengths and challenges and develop strategies to practice overcoming any obstacles.

| **Understandings:** Students will understand that... | **Essential Questions:** |
|---|---|
| ● Quadratic functions model situations involving parabolic patterns.<br>● The features of a parabola can be interpreted to make predictions and draw conclusions.<br>● If the product of two quantities equals zero, at least one of the quantities equals zero.<br>● There are a variety of methods to solve a quadratic equation and often one method will be more efficient than the others. | ● Why is it useful to write a polynomial in factored form?<br>● How do you determine the most efficient method to solve a quadratic?<br>● How do quadratic functions model real world phenomena?<br>● What do the vertex and intercepts tell us about the function? |
| **Students will know...** | **Students will be able to...** |
| ● Quadratic functions can be represented graphically, algebraically, or numerically.<br>● The best method for solving a quadratic equation depends on | ● Solve quadratic equations using square roots, factoring, and the quadratic formula.<br>● Defend/justify the most efficient approach to solving a quadratic |

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| the original format of the equation.<br>• Quadratic functions have an axis of symmetry through the vertex.<br>• The y-value of the vertex is the maximum or minimum of the quadratic function.<br>• The x-intercepts of the graph are the solutions of the equation.<br>• Previous knowledge (for example, area is length x width, revenue is product x price, etc.) can be represented by/applied to quadratic equations/functions. | equation.<br>• Graph quadratic functions in standard form.<br>• Connect the solutions of the equations with the x-intercepts of the function and connect the vertex with the maximum or minimum value.<br>• Use quadratic reasoning (for example, area is length x width, revenue is product x price, maximum = vertex, etc.) to solve problems. |
| **Key Vocabulary:** Quadratic function, axis of symmetry, maximum, minimum, x-intercept, y-intercept, roots, solutions, zeros, standard form, intercept form, quadratic formula, vertical motion model, zero product property | |
| **Assessment Evidence** | |
| **Performance Tasks:**<br>TCC3, AA1<br>**Summative Assessment: Test Unit 8 TCC3(9-12); AA1(9-12)**<br>• Solve quadratic equations using most efficient method<br>• Graph parabolas and identify key features<br>• Write a quadratic function to model projectile motion and other real world phenomena | **Other Evidence:**<br>Common Formative/Interim Assessments:<br>• Solving by square roots<br>• Solving by factoring<br>• Solving by quadratic formula<br>• Graphing parabolas and identifying key features |
| **Learning Plan** | |
| This unit continues the introduction to quadratics that students had in the polynomial unit.<br>• Students learn how to calculate the vertex of a parabola and use that to create a complete graph of a quadratic.<br>• Students identify the vertex, axis of symmetry, x-intercepts, y-intercept, domain, and range of a parabola.<br>• Students learn to calculate the values of the x-intercepts by solving the quadratic equation using square roots, factoring, and the quadratic formula.<br>• Students investigate the most efficient method for solving a quadratic equation.<br>• Students write quadratic equations to model real world situations, such as projectile motion or area. | |

| Lesson Focus | Learning Activities | CCSS Standards | VoL Attributes |
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| Lesson 1: Introducing Quadratic Functions | Explore contexts leading to quadratic relationships; distinguish between linear, exponential, and quadratic patterns. | HSF-IF.C.8a, HSF-IF.C.9 | TCC3, AA1, P1 |
| Lesson 2: Graphing Quadratic Functions | Plot quadratic functions from tables and equations; identify vertex and axis of symmetry. | HSF-IF.C.7a, HSF-IF.C.8a | TCC3, P1 |
| Lesson 3: Interpreting Features of Quadratic Graphs | Describe maximum/minimum values, intercepts, and symmetry in context. | HSF-IF.B.4, HSF-IF.C.8a | TCC3, AA1, |
| Lesson 4: Comparing Quadratic and Linear Functions | Compare growth rates and graph shapes of quadratic and linear functions in similar contexts. | HSF-IF.C.9 | TCC3, AA1, |
| Lesson 5: The Effect of 'a' in $y = ax^2$ | Investigate how varying 'a' changes the width and direction of a parabola. | HSF-BF.B.3, HSF-IF.C.8a | TCC3, |
| Lesson 6: The Effect of 'h' in $y = a(x-h)^2$ | Explore horizontal translations using vertex form; connect transformations to graph shifts. | HSF-BF.B.3, HSF-IF.C.8a | TCC3, AA1 |
| Lesson 7: The Effect of 'k' in $y = a(x-h)^2 + k$ | Analyze vertical shifts of parabolas; describe changes in vertex location. | HSF-BF.B.3, HSF-IF.C.8a | TCC3, AA1 |
| Lesson 8: Combining Transformations | Apply multiple transformations (vertical stretch, horizontal shift, vertical shift) to quadratics. | HSF-BF.B.3, HSF-IF.C.8a | TCC3, AA1, P1 |
| Lesson 9: Standard Form of Quadratic Functions | Expand vertex form to standard form; identify key features from standard form equations. | HSF-IF.C.8a, HSF-IF.C.8b | TCC3 |
| Lesson 10: Factoring Quadratic Expressions | Factor trinomials to find roots; connect factoring to x-intercepts of the graph. | HSA-SSE.B.3b, HSA-APR.B.3 | TCC3 |
| Lesson 11: Solving Quadratic Equations by Factoring | Solve quadratic equations set equal to zero using factoring; interpret solutions in context. | HSA-REI.B.4b | TCC3, AA1, P1 |

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| Lesson 12: Completing the Square | Rewrite quadratic expressions by completing the square; connect to vertex form. | HSA-SSE.B.2, HSA-SSE.B.3b, HSA-REI.B.4a | TCC3, AA1, P1 |
| Lesson 13: Solving Quadratic Equations by Completing the Square | Apply completing the square to solve equations; interpret results in context. | HSA-REI.B.4a | TCC3, P1 |
| Lesson 14: The Quadratic Formula | Derive and apply the quadratic formula; interpret solutions including irrational and complex roots. | HSA-REI.B.4b | TCC3, AA1, P1 |
| Lesson 15: Choosing a Solving Method (if time permits) | Compare factoring, completing the square, and the quadratic formula; choose an efficient method. | HSA-REI.B.4a, HSA-REI.B.4b | TCC3, AA1, P1 |
| Lesson 16: Applications of Quadratic Functions (if time permits) | Model real-world situations with quadratic functions; interpret vertex and intercepts. | HSF-IF.B.4, HSF-IF.C.8a, HSF-IF.C.8b | TCC3, AA1, P1 |
| Unit Assessment | Assess understanding of quadratic functions, equations, and applications. | HSF-IF.B.4, HSF-IF.C.7a, HSF-IF.C.8a, HSF-IF.C.8b, HSF-IF.C.9 | |

**Teacher Resources:** State of CT Algebra 1 Model Curriculum Unit 8; Algebra 1 Textbooks; Teacher created worksheets and assessments; Desmos; Khan academy; IXL; Socrative; Blooket; Quizizz; Kahoot