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Introduction to Modeling with Functions
Strength of Correlation
Regression Models
Performance Task: Super Survey Simulator
Course Customization

ABOUT THIS GUIDE

Edgenuity supplies teachers with a Teacher’s Guide to assist them in helping students succeed in every course. The Teacher’s Guide summarizes both the content that students learn in Algebra I based on the Louisiana Student Standards for Mathematics, and the eight Standards for Mathematical Practice in which students must be engaged for all of this content. For each unit, the guide provides teachers with focus standards as well as a pacing guide that organizes learning goals into lessons and includes the number of days suggested for each lesson. Discussion questions for each unit are included, paired with tips for effective discussions to support teachers in hosting them. Online lessons begin with a warm-up, dive into rich instruction, recap what students have learned in a summary, allow students to practice skills, and finally assess students in a quiz. When the structure of the online lessons are used as designed and combined with engaging non-routine problems and deep discussions with the questions provided, teachers are given everything they need to help their students succeed in a blended learning environment.

While technology has changed how content is delivered, it has not removed the student’s need for individualized instruction, remediation, or challenge—support that only a teacher can provide. That’s why each Teacher’s Guide comes with specific instructions for how to use Edgenuity’s innovative course customization toolset. This allows permissioned educators and district administrators to create truly customized courses that can meet the demands of the most rigorous classroom or provide targeted assistance for struggling students.

Finally, the Teacher’s Guide provides helpful resources, including a vocabulary list and key interactive tools that appear in online lessons.

SUMMARY OF ALGEBRA I MATHEMATICS CONTENT

Edgenuity Algebra I strictly adheres to the content specified by the Common Core State Standards in conjunction with Louisiana Student Standards for Mathematics. Students build on grades 6–8 by “deepen[ing] and extend[ing] their understanding of linear and exponential relationships, contrasting them with each other and applying linear models to data that exhibit a linear trend. Students engage in
methods for analyzing, solving, and using quadratic functions. The Mathematical Practice Standards apply throughout each course and, together with the content standards, prescribe that students experience mathematics as a coherent, useful, and logical subject that makes use of their ability to make sense of problem situations.” The descriptions below, from the official Common Core Traditional Pathway for High School Algebra I\(^1\), summarize the areas of instruction for this course.

**Critical Area 1**

By the end of eighth grade, students have learned to solve linear equations in one variable and have applied graphical and algebraic methods to analyze and solve systems of linear equations in two variables. Students now analyze and explain the process of solving an equation. Students develop fluency using various form of linear equations and inequalities to solve problems, as well as writing, interpreting, and translating between these forms. They master the solution of linear equations and apply related solution techniques and the laws of exponents to the creation and solution of simple exponential equations.

**Critical Area 2**

In earlier grades, students define, evaluate, and compare functions, and use them to model relationships between quantities. In Algebra I, students will learn function notation and develop the concepts of domain and range. They explore many examples of functions, including sequences; interpret functions given graphically, numerically, symbolically, and verbally; translate between representations; and understand the limitations of various representations. Students build on and informally extend their understanding of integer exponents to consider exponential functions. They compare and contrast linear and exponential functions, distinguishing between additive and multiplicative change. Students explore systems of equations and inequalities, and find and interpret their solutions. They interpret arithmetic sequences as linear functions and geometric sequences as exponential functions.

**Critical Area 3**

Students build on prior experiences with data, providing students with more formal means of assessing how a model fits data. Students use regression techniques to describe approximately linear relationships between quantities. They use graphical representations and knowledge of the context to make judgments about the appropriateness of linear models. With linear models, they look at residuals to analyze the goodness of fit.

**Critical Area 4**

Students build on their knowledge from Critical Area 2, where they begin to extend the laws of exponents to rational exponents. Students apply this new understanding of numbers and strengthen their ability to see structure in and create quadratic and exponential expressions. They create and solve equations, inequalities, and systems of equations involving quadratic expressions.

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CRITICAL AREA 5

Students consider quadratic functions, comparing the key characteristics of quadratic functions to those of linear and exponential functions. They select from among these functions to model phenomena. Students learn to anticipate the graph of a quadratic function by interpreting various forms of quadratic expressions. In particular, they identify the real solutions of a quadratic equation as the zeros of a related quadratic function. Students expand their experience with functions to include more specialized functions—absolute value, step, and those that are piecewise-defined.

STANDARDS FOR MATHEMATICAL PRACTICE IN EDGENUITY ALGEBRA I

The Standards for Mathematical Practice complement the content standards so students increasingly engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle, and high school years. These standards are the same at all grades from kindergarten to 12th grade, but the ways in which students practice them are unique to each course.

1. MAKE SENSE OF PROBLEMS AND PERSEVERE IN SOLVING THEM

Students in Edgenuity Algebra I are presented with multistep and novel problems that task them with being able to make sense of problems and persevere in solving them. They employ a problem-solving process, which consists of analyzing the question, identifying and interpreting the clues within the problem, developing a strategy to solve, and checking their work. The teacher repeatedly presents this problem-solving process across Algebra I topics, especially in modeling problems—from solving mixture problems to modeling with quadratic equations. Students may check their reasoning by asking themselves, “Is there another way to solve this problem?” or “Does this make sense?” At this level, students are encouraged to check their answers using a different approach.

2. REASON ABSTRACTLY AND QUANTITATIVELY

Abstract and quantitative reasoning are key focuses in Algebra I, and they are supported by Edgenuity courseware. Contextualizing is emphasized throughout the course when students create linear, quadratic, and exponential models, including equations, inequalities, and systems. Decontextualization is also emphasized, as students must use structure to solve problems involving these models, manipulate polynomials, and translate between multiple representations of equations and expressions.

3. CONSTRUCT VIABLE ARGUMENTS AND CRITIQUE THE REASONING OF OTHERS

Students are tasked with explaining their reasoning and analyzing the reasoning of others throughout Edgenuity Algebra I. At this level, students explain why a concept works, challenge or defend another student’s work, explain their solution path, compare two solution paths, and justify a conclusion.

4. MODEL WITH MATHEMATICS

In Edgenuity Algebra I, students extensively model real-world scenarios with equations arising from linear, quadratic, and exponential functions. They do so symbolically, graphically, and tabularly. They primarily focus on equations, inequalities, and systems, but may also model with expressions. As students move through a modeling problem, they create the model, solve problems using the model,
and interpret their answers in the context of the quantities they are modeling. They may ask themselves, “How can this model be improved?” and place restrictions on the model based on the context of the problem.

5. **Use Appropriate Tools Strategically**

Students consider available tools when solving a mathematical problem and decide when certain tools might be helpful. In Algebra I, students have these options:

- Graphing calculators to manage and represent data in different forms, solve a system, or help graph an advanced function
- Algebra tiles to help see structure in and manipulate expressions
- Regression calculators to determine an appropriate function model
- Interactive graphs to help them reason about or solve a problem or identify the effect(s) of function transformations
- Number lines to find and represent solution sets of inequalities
- Tables to organize data and set up difficult problems
- Estimation when an exact model is not available or needed

6. **Attend to Precision**

Algebra I students learn to communicate their ideas effectively using clear and accurate mathematical language. They learn the meaning and purpose of new mathematical symbols such as function notation, and choose sensible quantities to model, solve, and interpret problems. Students are precise when they express answers to modeling problems in a manner appropriate to the context of the problem. Students concentrate on completing each step of a problem correctly, attending to units throughout the solution process.

7. **Look for and Make Use of Structure**

Students extensively practice this standard in Algebra I when they use the structure of several kinds of expressions to identify ways to rewrite them. For example, students transform quadratic expressions by factoring and completing the square. In doing so, they can solve quadratic equations and convert quadratic functions from standard form to vertex form. They use the structure of vertex form to determine key features of the function. Edgenuity Algebra I students may also decompose complicated mathematical objects into their component parts to better understand and solve a problem.

8. **Look for and Express Regularity in Repeated Reasoning**

In Algebra I, students are given many opportunities to explore how changes to a specific function’s equation affect its graph. Through their investigations, students generalize how the coefficients and constants in a function equation impact the key features of the graph. Through their extensive work with linear, quadratic, and exponential functions, students in Algebra I can generalize these relationships and apply them to real-world scenarios. Students see patterns in the rate of change to determine an appropriate mathematical model for a situation or data set. In their work with polynomials, students attend to the structure of perfect square trinomials and difference of squares to understand the
formulas relating the polynomials to their factorizations. Students apply these patterns as they factor polynomials and complete the square. From different methods of solving linear systems to ways of solving quadratic equations, students in Algebra I are encouraged to ask themselves, “What approach will make my work more efficient?” In trying to answer this question, students look for similarities and patterns in problems.

**FOCUS IN EDGENUITY ALGEBRA I**

**UNIT 1: REPRESENTING RELATIONSHIPS**

*Estimated Unit Time: Approximately 18 Class Periods*

The first unit of Algebra I builds on the students’ basic quantitative and qualitative reasoning ideas from grade 8, in which they learned to use real numbers and variables to represent real-world scenarios with expressions and equations. In Representing Relationships, students extend these skills by analyzing and solving problems with abstract and quantitative representations (MP2). They contextualize by creating simple equations in two or more variables to represent relationships between quantities, and decontextualize by manipulating these equations and graphing them on coordinate axes (MP2). Students represent constraints of these relationships they created in the original context. Students use these more advanced abstract and quantitative skills to define functions in a new way: with domain and range. Function notation and evaluation are then emphasized, developing students’ attention to mathematical precision as they learn to understand and use function notation appropriately (MP6). This introductory unit lays a foundation for students to move into more advanced quantitative reasoning about special relationships between independent and dependent variables for multiple types of functions.

**Unit 1 Focus Standards**

The following focus standards are intended to guide teachers to be purposeful and strategic in both what to include and what to exclude when teaching this unit. Although each unit emphasizes certain standards, students are exposed to a number of key ideas in each unit, and as with every rich classroom learning experience, these standards are revisited throughout the course to ensure that students master the concepts with an ever-increasing level of rigor.

In the following table, **green highlights** indicate major work of the grade, **blue highlights** indicate supporting work, and **yellow highlights** indicate additional work.

<table>
<thead>
<tr>
<th>Standard Text</th>
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<tr>
<td>Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions.</td>
<td>A1:A-CED.A.1</td>
</tr>
<tr>
<td>Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</td>
<td>A1:A-CED.A.2</td>
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<td>Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</td>
<td>A1:A-CED.A.3</td>
</tr>
<tr>
<td>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.</td>
<td>A1:A-REI.A.1</td>
</tr>
<tr>
<td>Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</td>
<td>A1:A-REI.B.3</td>
</tr>
<tr>
<td>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).</td>
<td>A1:A-REI.D.10</td>
</tr>
<tr>
<td>Interpret parts of an expression, such as terms, factors, and coefficients.</td>
<td>A1:A-SSE.A.1.a</td>
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<tr>
<td>Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).</td>
<td>A1:F-IF.A.1</td>
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<tr>
<td>Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.</td>
<td>A1:F-IF.A.2</td>
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<tr>
<td>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.</td>
<td>A1:F-IF.B.5</td>
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<tr>
<td>Calculate and interpret the average rate of change of a linear, quadratic, piecewise linear (to include absolute value), and exponential function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.</td>
<td>A1:F-IF.B.6</td>
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<td>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.</td>
<td>A1:N-Q.A.1</td>
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<tr>
<td>Define appropriate quantities for the purpose of descriptive modeling.</td>
<td>A1:N-Q.A.2</td>
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<tr>
<td>Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</td>
<td>A1:N-Q.A.3</td>
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### Unit 1 Pacing Guide

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<th>Number of Days</th>
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<td>Quantitative Reasoning</td>
<td>• Describe a quantitative relationship shown in a table or graph, including graphs without scales.</td>
<td>A1:N-Q.A.1 A1:N-Q.A.2</td>
<td>1.5</td>
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<td>• Interpret a graph given with or without a scale to determine the quantitative relationship it describes.</td>
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<td>Dimensional Analysis</td>
<td>• Use dimensional analysis to convert units and compare quantities, attending to limitations on the unit of measurement.</td>
<td>A1:N-Q.A.1 A1:N-Q.A.2</td>
<td>1.5</td>
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<td>A1:N-Q.A.3</td>
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<tr>
<td>Expressions in One Variable</td>
<td>• Identify parts of an expression.</td>
<td>A1:A-SSE.A.1.a</td>
<td>1.5</td>
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<td>• Interpret expressions that represent a quantity in terms of its context.</td>
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<td></td>
<td>• Write expressions to represent scenarios.</td>
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<td></td>
<td>• Evaluate one-variable expressions.</td>
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<td>Writing and Solving Equations in Two Variables</td>
<td>• Solve for an unknown quantity in a two-variable linear equation, given one of the values.</td>
<td>A1:A-CED.A.2 A1:A-CED.A.3</td>
<td>2</td>
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<td>• Determine a two-variable linear equation that represents a scenario, identifying constraints on the variables in terms of the context.</td>
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<tr>
<td>Writing and Graphing Equations in Two Variables</td>
<td>• Construct a table of values and a graph for a two-variable linear equation that models a situation, pointing out solutions that are viable or not viable based on the context.</td>
<td>A1:N-Q.A.1 A1:A-CED.A.2 A1:A-REI.D.10 A1:F-IF.B.6</td>
<td>2</td>
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<td>• Write a two-variable linear equation to model a quantitative relationship, describing the constraints of the model based on the context.</td>
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<td>• Interpret graphs and rates by examining the quantities represented by each axis.</td>
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<td>Introduction to Functions</td>
<td>• Determine the domain and range of a functional relationship given in a mapping diagram, table, graph, or scenario.</td>
<td>A1:F-IF.A.1 A1:F-IF.B.5</td>
<td>2</td>
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## Lesson Objectives

### Function Notation
- Interpret function notation that models a real-world situation.
- Identify the input and output of a functional relationship, pointing out constraints on the domain and range.
- Use function notation to represent a functional relationship.

### Evaluating Functions
- Analyze a function represented by an equation, table, or graph to determine the output when given the input, and vice versa.
- Find input and output values of two functions graphed in the same coordinate plane.
- Write the inverse of a given linear function.

### Standards
- A1:F-IF.A.2

### Number of Days
- 2

## Discussion Questions & Answers

1. **What is the difference between an expression and an equation?**
   - An expression consists of constant and/or variable terms with one or more operations and does not have an equality sign. An equation consists of two equivalent expressions connected by an equality sign.

2. **Explain how the vertical line test determines if a relationship is a function.**
   - A relationship between two quantities is a function when for each independent value there is only one dependent value. That is, for each input, there is a unique output. Graphically, a function is determined by considering that for each x-value, there is only one y-value—also referred to as the vertical line test.

3. **Explain how to find the domain and range of a function given in a mapping diagram, table, or graph.**
   - **Mapping Diagram:** The domain will be the values that represent the independent quantity, usually referred to as the input, or x-values. The range will be the values that represent the dependent quantity, usually referred to as the output, or y-values.
   - **Table:** The domain will be the values in the first column that represent the independent quantity, usually referred to as the input. The range will be the values in the second column that represent the dependent quantity, usually referred to as the output.
   - **Graph:** The domain will be all the x-values that have points on the graph. The range will be all the y-values that have points on the graph.
Common Misconceptions

- Objects vs. a number of objects
  o Students discuss objects instead of a number of objects (quantities have measured values).
  o Students use variables to represent objects instead of a number of objects (e.g., \( x = \) apples, instead of \( x = \) a number of apples).
  o Students do not attend to the fact that we can operate on numbers, but we cannot operate on objects.

- Quantitative reasoning vs. shape thinking
  o Students think graphs are literal pictures of a situation.
  o Students do not reason quantitatively but will just use operations with numbers given in the word problem.

- Functions
  o Students may assume that table values (especially input values) are consecutive without attending to their actual values.
  o Students consider \( f(x) \) as an operation instead of a function, \( f \), defined in terms of \( x \).

- Discrete vs. continuous
  o Students may not attend to domain restrictions or context cues to recognize when a graph should be discrete vs. continuous.

- Order of operations
  o Students may neglect the order of operations, especially when subtraction precedes a term distribution.

Classroom Challenge

Write three separate scenarios about a relationship between two quantities where one is dependent on the other, and then draw a graph of your scenario. Be sure to describe the change in both quantities and label your graphs.

1. As the independent quantity increases, the dependent quantity increases at a constant rate.
2. As the independent quantity increases, the dependent quantity decreases at a constant rate.
3. As the independent quantity increases, the dependent quantity increases, decreases, and is constant.
Possible solution pathway:

1. Let \( x \) represent time in days and \( y \) represent growth in centimeters of tomato plants being grown in a greenhouse. As time increases, the growth of the plant increases. At 0 days, the height is 0 cm and after 6 days, the plant has a height of 3 cm.

2. Let \( x \) represent time in hours and \( y \) represent volume of water in gallons of a tank with a leak. As time increases, the amount of water left in the tank decreases. At 0 hours, the tank has 21 gallons of water, and at 7 hours, the tank is empty.
3. Let $x$ represent time in hours and $y$ represent the distance in miles of a bus from its starting point at the bus station during its daily pick-up route. As time increases, the bus increases the distance from the starting point. The bus stays at a constant distance during stops where passengers are loading and unloading. The bus’s distance from the start decreases as the driver returns the bus to the station.

![Graph](image)

Teacher notes:

Some students may struggle to get started, so prompt their thinking by asking them about the types of dependent relationships they are familiar with. For visual students, it may be easier to draw a graph first and then create a scenario.

Look for students who may switch the independent and dependent variables when graphing. If they have omitted labels on the axes, then have them label the axes. Then, ask the student to talk about the scenario while tracing the events out on the graph. The student should realize that it’s not always possible to match the scenario with the shape of the graph. However, if the student incorrectly interprets the graph, intervene with guiding questions. For example, “As time increases, how does the [distance, height, temperature, etc.] change?” or “How can we represent that visually?”

For more advanced students who need a challenge, ask them to create their scenarios without using time as the independent quantity.

**UNIT 2: LINEAR AND ABSOLUTE VALUE FUNCTIONS**

*Estimated Unit Time: Approximately 16 Class Periods*

This unit is intended to solidify and formalize students’ grasp of linear functions and equations by teaching them how to model in mathematical and real-world relationships and transform these functions with mathematics (MP4). Students connect what they learned about linear functions in 8th grade to Algebra I in this unit. By identifying, solving, and graphing these linear functions, students learn the different types and how they relate to equations for proportions. In this unit, students extend this knowledge of linear functions by creating linear equations arising from linear functions in two variables for the three classic forms. Students are also introduced to a new type of function—the absolute value
function, which is treated as a piecewise-defined linear function. Students’ understanding of linear functions becomes more sophisticated as they learn the definition of linear functions in terms of domain and range, rather than simply as a relationship between two quantities. Students calculate and interpret rate of change for all classic linear forms, learning that rate of change is the same quantity as slope (MP8)—often using function notation and evaluating functions for different values of the domain. Arithmetic sequences are related to linear functions as having a domain restricted to the natural numbers. Additionally, direct variation is introduced as a special linear relationship.

**Unit 2 Focus Standards**

The following focus standards are intended to guide teachers to be purposeful and strategic in both what to include and what to exclude when teaching this unit. Although each unit emphasizes certain standards, students are exposed to a number of key ideas in each unit, and as with every rich classroom learning experience, these standards are revisited throughout the course to ensure that students master the concepts with an ever-increasing level of rigor.

In the following table, green highlights indicate major work of the grade, blue highlights indicate supporting work, and yellow highlights indicate additional work.

<table>
<thead>
<tr>
<th>Standard Text</th>
<th>Standard ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</td>
<td>A1:A-CED.A.2</td>
</tr>
<tr>
<td>Determine an explicit expression, a recursive process, or steps for calculation from a context.</td>
<td>A1:F-BF.A.1.a</td>
</tr>
<tr>
<td>Identify the effect on the graph of replacing ( f(x) ) by ( f(x) + k ), ( kf(x) ), ( f(kx) ), and ( f(x + k) ) for specific values of ( k ) (both positive and negative). Without technology, find the value of ( k ) given the graphs of linear and quadratic functions. With technology, experiment with cases and illustrate an explanation of the effects on the graph that include cases where ( f(x) ) is a linear, quadratic, piecewise linear (to include absolute value), or exponential function.</td>
<td>A1:F-BF.B.3</td>
</tr>
<tr>
<td>Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If ( f ) is a function and ( x ) is an element of its domain, then ( f(x) ) denotes the output of ( f ) corresponding to the input ( x ). The graph of ( f ) is the graph of the equation ( y = f(x) ).</td>
<td>A1:F-IF.A.1</td>
</tr>
<tr>
<td>Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.</td>
<td>A1:F-IF.A.2</td>
</tr>
<tr>
<td>Recognize that sequences are functions whose domain is a subset of the integers. Relate arithmetic sequences to linear functions and geometric sequences to exponential functions.</td>
<td>A1.F-IF.A.3</td>
</tr>
<tr>
<td>Standard Text</td>
<td>Standard ID</td>
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<tr>
<td>For linear, piecewise linear (to include absolute value), quadratic, and exponential functions that model 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; and end behavior. 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. Calculate and interpret the average rate of change of a linear, quadratic, piecewise linear (to include absolute value), and exponential function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. Graph linear and quadratic functions and show intercepts, maxima, and minima. Graph piecewise linear (to include absolute value) and exponential functions. Compare properties of two functions (linear, quadratic, piecewise linear (to include absolute value), or exponential) 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, determine which has the larger maximum. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table). Interpret the parameters in a linear, quadratic, or exponential function in terms of a context.</td>
<td>A1:F-IF.B.4</td>
</tr>
</tbody>
</table>
## Unit 2 Pacing Guide

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
</table>
| **Introduction to Linear Functions** | • Calculate the rate of change of a function and, if constant, the initial value of the function.  
• Determine if a relationship is linear by analyzing the rate of change.                                                                 | A1:F-IF.A.1  
A1:F-IF.B.6  
A1:F-IF.C.9  
A1:F-LE.A.1.a  
A1:F-LE.A.1.b  
A1:F-LE.B.5 | 2 |
| **Slope of a Line**              | • Identify if the slope of a linear relationship is zero, positive, negative, or undefined.  
• Determine the slope of a line from a graph, table of values, or ordered pairs.  
• Interpret slope in the context of real-world scenarios.                                                                                 | A1:F-IF.B.6  
A1:F-LE.B.5 | 2 |
| **Slope-Intercept Form of a Line** | • Identify the slope and y-intercept of a linear function, and use them to graph the function.  
• Write a linear function, in slope-intercept form, for a given relationship.  
• Analyze how a change in a parameter of a linear function affects its graph or the scenario it represents.                             | A1:A-CED.A.2  
A1:F-IF.B.4  
A1:F-IF.B.6  
A1:F-IF.C.7.a  
A1:F-LE.A.2  
A1:F-BF.B.3 | 1.5 |
| **Point-Slope Form of a Line**   | • Write the equation of a line given its slope and a point on the line in point-slope form, and express the relationship as a function.  
• Graph a line given its equation in point-slope form, identifying the slope and intercepts.                                           | A1:A-CED.A.2  
A1:F-IF.A.2  
A1:F-IF.B.6  
A1:F-IF.C.7.a  
A1:F-LE.A.2 | 1.5 |
| **Standard Form of a Line**      | • Write the equation of a line in standard form given a graph or scenario.  
• Graph a line given its equation in standard form, identifying the slope and intercepts.                                                 | A1:A-CED.A.2  
A1:F-LE.A.2  
A1:F-IF.C.7.a  
A1:F-LE.B.5 | 1.5 |
| **Writing Linear Equations**     | • Write two-variable linear equations in different forms using varying pieces of information about the relationships.  
• Use linear models to solve problems.                                                                                                        | A1:A-CED.A.2  
A1:F-IF.A.2  
A1:F-IF.B.6  
A1:F-IF.C.9 | 2 |
### Lesson Objectives

<table>
<thead>
<tr>
<th>Special Linear Relationships</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Determine if a relationship is a direct variation.</td>
<td>A1:A-CED.A.2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>• Find the constant of variation in a direct variation.</td>
<td>A1:F-IF.A.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Write an equation for a direct variation.</td>
<td>A1:F-IF.A.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Write recursive and explicit rules for arithmetic sequences using function notation.</td>
<td>A1:F-IF.B.4</td>
<td></td>
</tr>
<tr>
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<td>A1:F-IF.B.6</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Absolute Value Functions and Translations</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Graph the absolute value function and its translations.</td>
<td>A1:F-BF.B.3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Analyze key features of the absolute value function and its translations.</td>
<td>A1:F-IF.C.7.b</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reflections and Dilations of Absolute Value Functions</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Graph reflections and dilations of the absolute value function.</td>
<td>A1:F-IF.B.5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• State the domain and range of reflections and dilations of the absolute value function.</td>
<td>A1:F-IF.C.7.b</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• State the domain and range of reflections and dilations of the absolute value function.</td>
<td>A1:F-BF.B.3</td>
<td></td>
</tr>
</tbody>
</table>

### Discussion Questions & Answers

1. **What are the three ways to write the equation of a line? Why would one form be more useful than another?**
   - **Standard form:** $Ax + By = C$; $A$ is a positive whole number, $B$ and $C$ are whole numbers
   - **Point-slope form:** $y - y_1 = m(x - x_1)$; $(x_1, y_1)$ is a point on the line, $m$ is the slope
   - **Slope-intercept form:** $y = mx + b$; $m$ is the slope, $b$ is the $y$-intercept
   - **a.** It is useful to use standard form when finding the $x$-intercept and the $y$-intercept. It is useful to use point-slope form when given the slope and an ordered pair, or two ordered pairs that are not intercepts. It is useful to use slope-intercept form when given or finding the slope and the $y$-intercept.

2. **What are the characteristics of a linear function? What does the graph look like?**
   - **a.** A linear function has a constant rate of change, called slope. That is, between any two points on the line, the rate created from the change in the output to the change in the input is the same throughout.
   - **b.** The graph looks like a straight line that is increasing over the entire domain, decreasing over the entire domain, or constant through the entire domain.

3. **What are the characteristics of an absolute value function? What does the graph look like?**
a. Absolute value functions have two linear pieces that meet at a point. The linear pieces have the same magnitude of slope but opposite signs. Non-transformed absolute value functions will only have positive outputs.

b. The graph looks like a “V” that is decreasing for half of the domain and increasing for the other half of the domain.

**Common Misconceptions**

- **Structure of slope**
  - Students see slope as a special letter, m, or memorized “rise over run” and not quantification of the change in the dependent variable per change in the independent variable.
  - Students see slope as a point and not a map to move between points.

- **Meaning of intercepts**
  - Students do not always internalize the meaning of an intercept.
  - The x-intercept(s) is(are) the value(s) of x when y = 0.
  - The y-intercept is not just b, but the y-value when x = 0.

- **Slope calculations**
  - Students calculate slope as the change in x over the change in y.
  - Students mismatch coordinates.
    - For example, if students are calculating the slope between points (1,2) and (3,4), they write $m = \frac{4-2}{1-3}$.

- **Switching parameters of slope-intercept form**
  - Students will take the first number listed as slope and the last number as the y-intercept.
  - Students will not recognize that when linear equations are not in slope-intercept form the coefficient on x is not the slope.

- **Structure of variable terms with fractional coefficients**
  - Students will not always see the equivalence in variable terms with fractional coefficients written in different ways.
    - For example, they do not realize that $\frac{3}{2}x = \frac{3x}{2} = 3x \cdot \frac{1}{2}$.

- **Horizontal shifts**
  - Students shift functions incorrectly when a constant is added or subtracted from the input value.
    - For example, $f(x + c)$ shifts left and not right or $f(x - c)$ shifts right and not left.

**Classroom Challenge**
Consider the arithmetic sequence $a, b, c, 32$, where $a$ is the first term, $b$ is the second term, $c$ is the third term, and $32$ is the fourth term. The sum of the second and third term is 37.

1. Find the common difference and the values for $a$, $b$, and $c$.
2. What is the recursive form of the arithmetic sequence?
3. What is the explicit form of the arithmetic sequence?

Possible solution pathway:

The problem states that the sum of the second and third term is 37. That means:

$$b + c = 37$$  (1)

We know that the common difference, $d$, is the difference between any two consecutive numbers in an arithmetic sequence. That means:

$$32 - c = d$$  (2)

$$c - b = d$$  (3)

Since equations (2) and (3) are each equal to $d$, we can set them equal to each other.

$$32 - c = c - b$$

Solve for $b$.

$$b = 2c - 32$$

Now we can substitute in $2c - 32$ for $b$ in equation (1).

$$2c - 32 + c = 37$$

Solve for $c$.

$$3c = 69$$

$$c = 23$$

That means the third term of the sequence is 23. Therefore, the sequence is $a, b, 23, 32$.

The difference between the fourth and third terms will be the common difference.

$$d = 32 - 23 = 9$$

We can find the other terms by subtracting the common difference, 9, from the term that comes after $b$.

$$b = 23 - 9 = 14$$

$$a = 14 - 9 = 5$$
Therefore, the sequence is 5, 14, 23, 32.

Now we can find the recursive form for this sequence. The first term is 5 and the common difference is 9, so we know that:

\[ f(1) = 5 \]
\[ f(n + 1) = f(n) + 9 \]

Now we can find the explicit form for this sequence. We know the common difference is 9. This is the same as the slope of a line, so we know that:

\[ y = 9x + b \]

Since \( f(1) = 5 \), we can substitute in 1 for \( x \) and 5 for \( y \) and solve for \( b \).

\[ 5 = 9(1) + b \]
\[ b = -4 \]

Therefore, the explicit form of the arithmetic sequence is \( y = 9x - 4 \). In function notation, this is \( f(x) = 9x - 4 \).

**Teacher notes:**

For students who struggle to get started, remind them that the common difference is the difference between any two consecutive numbers in an arithmetic sequence. Ask them to write equations that relate the terms of the sequence and the common difference. They can use these equations to solve for the common difference and find the values of the terms of the sequence.

Students might not remember the difference between the recursive and explicit form of a function. A recursive sequence is a function of the preceding terms given one or more previous terms. So for the given sequence, that means the value of \( b \) depends on the value of \( a \), and the value of \( c \) depends on the value of \( b \). An explicit form of the sequence does not require the preceding term. It can be used to find any term directly, without knowing the value of other terms.

To extend the problem further, ask student to graph the function on a coordinate plane and identify the domain.

**UNIT 3: ONE-VARIABLE EQUATIONS AND INEQUALITIES**

*Estimated Unit Time: Approximately 19 Class Periods*

As in the previous unit, students extend the 8th-grade concept of solving equations to creating equations. Students gain fluency in creating equations and inequalities in one variable and solving linear equations and inequalities in one variable, especially in context. Students learn multiple cases of solving one-variable linear equations and solving single-step and multistep inequalities. Another skill students hone in this unit is representing constraints by equations and inequalities, and interpreting solutions of
equations and inequalities in a modeling context. They extend their newfound fluency to solving challenging mixture and rate problems. Students must make sense of these problems using the problem-solving process as a form of mathematical argument and persevere in solving them (MP1 and MP3). Students are also introduced to literal equations in this unit.

**Unit 3 Focus Standards**

The following focus standards are intended to guide teachers to be purposeful and strategic in both what to include and what to exclude when teaching this unit. Although each unit emphasizes certain standards, students are exposed to a number of key ideas in each unit, and as with every rich classroom learning experience, these standards are revisited throughout the course to ensure that students master the concepts with an ever-increasing level of rigor.

In the following table, **green highlights** indicate major work of the grade, **blue highlights** indicate supporting work, and **yellow highlights** indicate additional work.

<table>
<thead>
<tr>
<th>Standard Text</th>
<th>Standard ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions.</td>
<td>A1:A-CED.A.1</td>
</tr>
<tr>
<td>Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</td>
<td>A1:A-CED.A.3</td>
</tr>
<tr>
<td>Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.</td>
<td>A1:A-CED.A.4</td>
</tr>
<tr>
<td>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.</td>
<td>A1:A-REI.A.1</td>
</tr>
<tr>
<td>Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</td>
<td>A1:A-REI.B.3</td>
</tr>
<tr>
<td>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, piecewise linear (to include absolute value), and exponential functions.</td>
<td>A1:A-REI.D.11</td>
</tr>
<tr>
<td>Lesson</td>
<td>Objectives</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Equations in One Variable</td>
<td>• Explain the steps used to solve a two-step, one-variable linear equation.</td>
</tr>
<tr>
<td></td>
<td>• Create two-step, one-variable linear equations to model problems.</td>
</tr>
<tr>
<td></td>
<td>• Solve two-step, one-variable linear equations, and simple absolute value equations, pointing out solutions that are viable or not viable in a modeling context.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Solving Linear Equations:</td>
<td>• Determine the input value that produces the same output value for two functions from a table or graph.</td>
</tr>
<tr>
<td>Variable on One Side</td>
<td>• Explain the steps used to solve a one-variable linear equation having the variable on one side only.</td>
</tr>
<tr>
<td></td>
<td>• Solve one-variable linear equations having the variable on one side only, pointing out solutions that are viable or not viable in a modeling context.</td>
</tr>
<tr>
<td></td>
<td>• Create one-variable linear equations, having the variable on one side only, to model and solve problems.</td>
</tr>
<tr>
<td>Solving Linear Equations:</td>
<td>• Explain the steps used to solve a one-variable linear equation having the variable on both sides.</td>
</tr>
<tr>
<td>Variables on Both Sides</td>
<td>• Solve one-variable linear equations having the variable on both sides using tables, graphs, or algebra, pointing out solutions that are viable or not viable in a modeling context.</td>
</tr>
<tr>
<td></td>
<td>• Create one-variable linear equations, having the variable on both sides, to model and solve problems.</td>
</tr>
<tr>
<td>Solving Linear Equations:</td>
<td>• Solve one-variable linear equations involving the distributive property.</td>
</tr>
<tr>
<td>Distributive Property</td>
<td>• Determine if a one-variable linear equation has zero, one, or infinite solutions.</td>
</tr>
<tr>
<td></td>
<td>• Create one-variable linear equations involving the distributive property to model and solve problems.</td>
</tr>
<tr>
<td>Literal Equations</td>
<td>• Rearrange a literal equation to highlight a quantity of interest and use it to solve problems.</td>
</tr>
<tr>
<td></td>
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<tr>
<td>Lesson</td>
<td>Objectives</td>
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<tr>
<td>------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Inequalities in One Variable | • Explain the steps used to solve a two-step one-variable linear inequality.  
• Solve two-step one-variable linear inequalities and state the solution in set or interval notation or graph it on a number line.  
• Create two-step one-variable linear inequalities to model and solve problems, pointing out solutions that are viable or not viable in the context. | A1:A-CED.A.1  
A1:A-CED.A.3  
A1:A-REI.B.3 | 1.5 |
| Solving One-Variable Inequalities | • Explain the steps used to solve a multistep one-variable linear inequality.  
• Solve multistep one-variable linear inequalities.  
• Graph the solution sets of one-variable linear inequalities. | A1:A-CED.A.1  
A1:A-CED.A.3  
A1:A-REI.B.3 | 1.5 |
| Solving Mixture Problems     | • Use a table to organize information given in mixture problems.  
• Write and solve one-variable linear equations to model and solve mixture problems. | A1:A-CED.A.1  
A1:A-REI.B.3 | 2 |
| Solving Rate Problems        | • Use a table to organize information given in time-distance-rate and work problems.  
• Write and solve one-variable linear equations to model and solve time-distance-rate and work problems. | A1:A-CED.A.1  
A1:A-REI.B.3 | 2 |
| Problem Solving              | • Apply problem-solving strategies to analyze problems and construct equations.  
• Solve equations and interpret the solutions in context. | A1:A-CED.A.1  
A1:A-REI.B.3 | 1.5 |
| Unit Test                    |                                                                                                                                           |                               | 1 |

**Discussion Questions & Answers**

1. How is solving an absolute value equation similar to/different from solving a linear equation?
   a. *When solving an absolute value equation, there are two possible equations: one for the positive solution and one for the negative solution. Once the absolute value equation is broken into two linear equations, each is solved like a normal linear equation.*

2. How is solving an inequality similar to/different from solving an equation?
   a. *When solving an inequality, the properties of operations are used in the same way as solving an equation. However, multiplying or dividing by a negative number when solving an inequality requires the inequality to change directions. In addition, the solution to a linear equation is a number, whereas the solution to a linear inequality is a set of numbers.*
3. How are the properties of equality used to solve linear equations?
   
   a. The properties of equality create equivalent equations by performing the same operation on each side of the equals sign in order to isolate the variable.

Common Misconceptions

- Students may try to solve a rate problem without first making sure the units of the quantities are the same.

- Equality
  - Students interpret the equals sign as the symbol that precedes an answer instead of “the same as.”
  - Students see the equals sign as the result of performing operations or call for operations instead of the equivalence of two statements.

- Objects vs. a number of objects
  - Students discuss objects instead of a number of objects (quantities have measured values).
  - Students use variables to represent objects instead of a number of objects.
    - For example, \( x = \) apples instead of \( x = \) a number of apples.
  - Students do not attend to the fact that we can operate on numbers, but we cannot operate on objects.

- Variables represent one number instead of an interval of numbers
  - Students incorrectly state solutions of inequalities as a single number instead of a set of numbers.

- Keywords
  - Students have an overreliance on keywords they used in elementary mathematics as operational cues without attending to the situation of dealing with an inequality.
    - For example, “more than” means add instead of compare.

- Inverse operations
  - Students do not recognize the inverse operation needed to isolate a term having a negative coefficient.
    - For example, adding 2 to both sides of the equation when solving \(-2x = 10\).

- Clearing fractions
  - Students only multiply the fractional terms in an equation by the number to convert them to whole numbers, as opposed to multiplying through to every term in the equation.

- Inequalities
Students do not use the opposite inequality when multiplying or dividing by a negative number.

Students use the opposite inequality when subtracting or adding a negative number to both sides of an inequality.

Students believe that the inequality symbol is an “arrow” for the solution graphed on the number line.

**Classroom Challenge**

A dog-boarding service has reservations for twice as many boxers as collies, and for 2 more poodles than collies.

1. If there are 21 cages in all, what is the greatest number of collies that can be boarded?
2. Assuming that number of collies is boarded, how many poodles and boxers are boarded?
3. How many cages are empty?

**Possible solution pathway:**

First, we can choose a variable, \( c \), to represent how many reservations there can be for collies. We can then use \( c \) to write an expression representing the number of reservations for each type of dog.

\[
\begin{align*}
\text{Number of collies} & = c \\
\text{Number of boxers} & = 2c \\
\text{Number of poodles} & = c + 2
\end{align*}
\]

If there are 21 cages and each dog has its own cage, the number of collie reservations plus the number of boxer reservations plus the number of poodle reservations must be less than or equal to 21. We can write a one-variable inequality to represent the total number of reservations.

\[
c + 2c + c + 2 \leq 21
\]

Combining like terms:

\[
4c + 2 \leq 21
\]

Solving for \( c \):

\[
c \leq 4.75
\]

There can be at most 4 reservations for collies.

• If there are 4 reservations for collies, then there are 8 reservations for boxers and 6 reservations for poodles.
• There would be a total of 18 reservations, which leaves 3 cages empty.
Teacher notes:

To help struggling students get started, encourage them to pick one variable to work with. The variable should represent the number of reservations for the breed being compared to both of the other breeds.

Students might have trouble determining the answer once they solve and get a fraction or decimal. Remind them that we are talking about the number of reservations, so it must be a whole number and they must round down.

Advanced students can solve using more than one variable. They can then use substitution to write an inequality with only one variable.

**UNIT 4: SYSTEMS OF LINEAR EQUATIONS**

*Estimated Unit Time: Approximately 10 Class Periods*

In Systems of Linear Equations, students move from a general understanding of simple systems of linear equations (in 8th grade) to a deeper conceptualization as they learn how to model real-world situations with systems. They become fluent in solving systems of linear equations using a variety of methods, including graphing, substitution, and linear combination. Students are introduced to proving that linear combination is a valid way to solve a linear system, as replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions. They also become well-versed in writing systems to model real-world contexts using one- and two-variable equations (MP4) and solving the systems they construct (MP2), interpreting the solutions in context (MP2).

**Unit 4 Focus Standards**

The following focus standards are intended to guide teachers to be purposeful and strategic in both what to include and what to exclude when teaching this unit. Although each unit emphasizes certain standards, students are exposed to a number of key ideas in each unit, and as with every rich classroom learning experience, these standards are revisited throughout the course to ensure that students master the concepts with an ever-increasing level of rigor.

In the following table, green highlights indicate major work of the grade, blue highlights indicate supporting work, and yellow highlights indicate additional work.

<table>
<thead>
<tr>
<th>Standard Text</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions.</td>
<td>A1:A-CED.A.1</td>
</tr>
<tr>
<td>Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</td>
<td>A1:A-CED.A.2</td>
</tr>
<tr>
<td>Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</td>
<td>A1:A-CED.A.3</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Standard Text</th>
<th>Standard ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prove that, given a system of two equations in two variables, replacing one</td>
<td>A1:A-REI.C.5</td>
</tr>
<tr>
<td>equation by the sum of that equation and a multiple of the other produces a</td>
<td></td>
</tr>
<tr>
<td>system with the same solutions.</td>
<td></td>
</tr>
<tr>
<td>Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.</td>
<td>A1:A-REI.C.6</td>
</tr>
</tbody>
</table>

### Unit 4 Pacing Guide

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
</table>
| **Introduction to Systems of Linear Equations** | • Create a system of linear equations to model a problem.  
• Solve a system of linear equations graphically, using technology as a tool for finding the solution, when appropriate.  
• Interpret the solution of a system of linear equations in a modeling context. | A1:A-CED.A.2  
A1:A-CED.A.3  
A1:A-REI.C.6 | 2               |
| **Solving Systems of Linear Equations: Graphing** | • Use technology to find or approximate the solution of a system of linear equations graphically.  
• Analyze a system of linear equations to determine if it has one solution, no solution, or infinitely many solutions. | A1:A-REI.C.6 | 1.5            |
| **Solving Systems of Linear Equations: Substitution** | • Solve a system of linear equations using substitution.  
• Interpret the solution of a system of linear equations in a modeling context. | A1:A-REI.C.6 | 1.5            |
| **Solving Systems of Linear Equations: Linear Combinations** | • Solve systems of linear equations using linear combinations, limiting the systems to those that do not require multiples of both equations.  
• Interpret the solution of a system of linear equations in a modeling context.  
• Verify that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions. | A1:A-REI.C.5  
A1:A-REI.C.6 | 1               |
| **Solving Systems of Linear Equations: Linear Combinations** | • Solve a system of linear equations using linear combinations.  
• Interpret the solution of a system of linear equations in a modeling context. | A1:A-REI.C.6 | 1               |
### Lesson Objectives

- Create a system of linear equations to model a problem.
- Interpret the solution of a system of linear equations in a modeling context.

### Standards

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
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<th>Number of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling with</td>
<td>• Create a system of linear equations to model a problem.</td>
<td>A1:A-CED.A.1</td>
<td>2</td>
</tr>
<tr>
<td>Equations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit Test</td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

### Discussion Questions & Answers

1. **What are the different ways a system of linear equations can be solved? Why would one way be more useful than another?**
   
   - A system of linear equations can be solved graphically, using substitution, or by using a method of variable elimination.
   
   - One method of solving a system of linear equations is more useful depending on how the equations are written and what the coefficients of the variables are.

2. **What does it mean graphically for a system of linear equations to have zero solutions? One solution? Infinite solutions?**
   
   - When a system of linear equations has zero solutions the two lines will be parallel, which means graphically they will not intersect.
   
   - When a system of linear equations has one solution, the two lines will intersect at one point.
   
   - When a system of linear equations has infinite solutions, the two lines will be on top of each other because they are the same line, which means graphically there will be only one line shown.

3. **Explain why a system of two linear equations cannot have exactly two solutions.**
   
   - A system of linear equations can only have 0, 1, or infinite solutions because the lines either do not intersect, intersect at one point, or are the same line. The graphs of linear functions are straight lines that will not bend back to intersect again.

### Common Misconceptions

- **Clearing fractions**
  
  - Students only multiply the fractional terms in an equation by the number to convert them to whole numbers, as opposed to multiplying through to every term in the equation.

- **Solutions to systems of equations**
  
  - Students will stop after they have found x, not internalizing or remembering that the solution is an ordered pair that exists on both functions.
Classroom Challenge

Hanna and her friends went to a community celebration and made the following purchases:

- A glow stick and a sparkler for $1.50
- A glow stick and a kazoo for $1.80
- A sparkler and a kazoo for $2.00

Can you find the price of each item?

Possible solution pathway:

Notice that combining any two equations results in double one price plus the sum of the prices of the other two items. For example:

\[
g + s = 1.50
\]
\[
g + k = 1.80
\]
\[
s + k = 2.00
\]

Adding the first two equations:

\[
2g + s + k = 3.30
\]

Substituting 2.00 for \( s + k \):

\[
2g + 2.00 = 3.30
\]

\[
2g = 1.30
\]

\[
g = 0.65
\]

This value can be substituted into the other equations to solve for \( s \) and \( k \).

\[
g + s = 1.50
g + k = 1.80
\]
\[
0.65 + s = 1.50
0.65 + k = 1.80
\]
\[
s = 0.85
k = 1.15
\]
Teacher notes:

Struggling students might be overwhelmed with three different variables. Help them to define the variables as a cost of an item and set up the equations. Encourage them to solve by substituting if adding two equations together seems too complicated.

Advanced students should solve by graphing. Let \( g \) be the independent quantity (\( x \)-value) and \( s \) be the dependent quantity (\( y \)-value). Use the third equation to solve for \( k \) in terms of \( s \) and substitute this value into the second equation. Finally, have students graph the first and second equation to find the point of intersection \((g, s)\).

UNIT 5: COMPOUND INEQUALITIES AND SYSTEMS

Estimated Unit Time: Approximately 14 Class Periods

In Compound Inequalities and Systems, students extend their knowledge of creating and solving linear equations to creating and solving linear inequalities. Students learn when to model with inclusive inequality symbols versus strict inequality symbols as they apply to one-variable, two-variable, and compound inequalities (MP6). While students solve inequalities in previous grade levels, they have not yet created inequalities in one and two variables (MP4) and solve the inequalities they created (MP2). Students are also introduced to graphing inequalities in two variables, extending their knowledge of graphing one-variable inequalities on a number line. The on-screen teachers help students develop the skill of representing constraints of inequalities in one and two variables, interpreting solutions as viable or not viable in mathematical and real-world contexts (MP2). The unit’s coverage is limited to relationships arising from linear functions.

Unit 5 Focus Standards

The following focus standards are intended to guide teachers to be purposeful and strategic in both what to include and what to exclude when teaching this unit. Although each unit emphasizes certain standards, students are exposed to a number of key ideas in each unit, and as with every rich classroom learning experience, these standards are revisited throughout the course to ensure that students master the concepts with an ever-increasing level of rigor.

In the following table, green highlights indicate major work of the grade, blue highlights indicate supporting work, and yellow highlights indicate additional work.

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<td>Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions.</td>
<td>A1:A-CED.A.1</td>
</tr>
<tr>
<td>Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</td>
<td>A1:A-CED.A.3</td>
</tr>
</tbody>
</table>
### Standard Text

**Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.**

**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.**

### Unit 5 Pacing Guide

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Compound Inequalities</td>
<td>• Write compound inequalities to model problems.</td>
<td>A1:A-CED.A.1</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>• Relate the solution set of a compound inequality to its graph.</td>
<td>A1:A-CED.A.3</td>
<td></td>
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<tr>
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</tr>
<tr>
<td>Solving Compound Inequalities</td>
<td>• Solve one-variable compound inequalities, pointing out solutions that are viable or not viable in a modeling context, and graph the solutions.</td>
<td>A1:A-CED.A.1</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>• Create one-variable compound linear inequalities to model and solve problems.</td>
<td>A1:A-CED.A.3</td>
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<tr>
<td></td>
<td></td>
<td>A1:A-REI.B.3</td>
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</tr>
<tr>
<td>Two-Variable Linear Inequalities</td>
<td>• Write a linear inequality to model a relationship between two quantities.</td>
<td>A1:A-CED.A.3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>• Interpret the solution set of a two-variable linear inequality.</td>
<td>A1:A-REI.D.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Graph two-variable linear inequalities.</td>
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</tr>
<tr>
<td>Graphing Two-Variable Linear Inequalities</td>
<td>• Relate the graph of a two-variable linear inequality to its algebraic representation.</td>
<td>A1:A-CED.A.3</td>
<td>2</td>
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<tr>
<td></td>
<td></td>
<td>A1:A-REI.D.12</td>
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<tr>
<td>Modeling with Two-Variable Linear Inequalities</td>
<td>• Create a two-variable linear inequality to model a problem.</td>
<td>A1:A-CED.A.3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>• Graph the solutions to a two-variable linear inequality.</td>
<td>A1:A-REI.D.12</td>
<td></td>
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<tr>
<td></td>
<td>• Interpret the solutions of a two-variable linear inequality in a modeling context.</td>
<td>A1:A-REI.B.3</td>
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<tr>
<td></td>
<td>• Graph a system of two-variable linear inequalities.</td>
<td>A1:A-REI.D.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Determine a system of two-variable linear inequalities given a solution set.</td>
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### Lesson Objectives

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</table>
| Modeling with Systems of Linear Inequalities | • Create a system of two-variable linear inequalities to model a problem.  
• Graph the solutions to a system of two-variable linear inequalities.  
• Interpret the solutions to a system of two-variable linear inequalities in a modeling context. | A1:A-CED.A.3  
A1:A-REI.D.12 | 2 |
| Unit Test                      |                                                                           |                                  | 1              |

### Discussion Questions & Answers

1. How is a compound inequality different from a single inequality?
   a. A compound inequality involves two inequalities at the same time, either written as one statement with two inequality symbols (or with “and”) or written as two inequalities connected by “or.”

2. How is the graph of the solution set for a two-variable inequality different from that of a one-variable inequality?
   a. The graph of the solution set of a one-variable inequality is a number line with an endpoint that indicates inclusion or not, and shading with an arrow in the direction of the inequality. The graph of the solution set of a two-variable inequality is a line that shows inclusion or not by being solid or dashed, and has shading above or below depending on the inequality.

3. What is the difference between solving a system of linear inequalities and solving a system of linear equations? What is similar between solving the two types of systems?
   a. The solution to a system of linear equations is a point of intersection and the solution to a system of linear inequalities is a region where the two shaded areas overlap. Both systems of equations and inequalities can have parallel lines with no solution or the same line with infinite solutions.

### Common Misconceptions

- Inequalities
  o Students do not use the opposite inequality when multiplying or dividing by a negative number.
  o Students use the opposite inequality when subtracting or adding a negative number to both sides of an inequality.
  o Students believe that the inequality symbol is an “arrow” for the solution graphed on the number line.
Classroom Challenge

Write a system of inequalities that represents the given solution set graphed below. State any point in the solution set.

Possible solution pathway:

The decreasing, dashed line has a y-intercept of (0, –6) and a slope of –2.

\[ y > -2x - 6 \]

The increasing solid line has a y-intercept of (0, 4) and a slope of \( \frac{1}{2} \).

\[ y \leq \frac{1}{2}x + 4 \]

A point in the solution set is (0, 0).

Teacher notes:

For struggling students, encourage them to determine two points for each line to use the slope formula to determine the slope.

Remind students that the solid or dashed aspect of the line determines the type of inclusion with the inequality. The point (–4, 2) is not a solution because it would not satisfy the inequality \( y > -2x - 6 \).

Ask advanced students to graph the same system with the inequalities reversed, showing the solution set graphically. Have students compare the original and the new solution sets.
**UNIT 6: EXPONENTIAL FUNCTIONS**

*Estimated Unit Time: Approximately 14 Class Periods*

Unit 6 expands students’ function bank by introducing students to exponential functions for the first time. To connect this new topic to prior knowledge, the teacher reminds students of simplifying and evaluating exponential expressions in the warm-up. Students learn that exponential functions come in two forms: growth and decay. Modeling with both types of exponential functions is included for each type of exponential function (MP4), including creating exponential equations with one and two variables and calculating and interpreting the rate of change of exponential functions. Students are exposed to exponential function transformations, with extensive exercises in graphing parent and transformed exponential functions with special attention to relating the domain of an exponential function to its graph. Finally, students relate geometric sequences to exponential functions, finding a pattern in the similar structures of geometric sequences and exponential functions (MP8).

**Unit 6 Focus Standards**

The following focus standards are intended to guide teachers to be purposeful and strategic in both what to include and what to exclude when teaching this unit. Although each unit emphasizes certain standards, students are exposed to a number of key ideas in each unit, and as with every rich classroom learning experience, these standards are revisited throughout the course to ensure that students master the concepts with an ever-increasing level of rigor.

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<tbody>
<tr>
<td>Create equations and inequalities in one variable and use them to solve problems. <strong>Include equations arising from linear, quadratic, and exponential functions.</strong></td>
<td>A1:A-CED.A.1</td>
</tr>
<tr>
<td>Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</td>
<td>A1:A-CED.A.2</td>
</tr>
<tr>
<td>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, piecewise linear (to include absolute value), and exponential functions.</td>
<td>A1:A-REI.D.11</td>
</tr>
<tr>
<td>Use the properties of exponents to transform expressions for exponential functions emphasizing integer exponents. <em>For example, the growth of bacteria can be modeled by either f(t) = 3^{(t+2)} or g(t) = 9(3^t) because the expression 3^{(t+2)} can be rewritten as (3^t)(3^2) = 9(3^t).</em></td>
<td>A1:A-SSE.B.3.c</td>
</tr>
<tr>
<td>Standard Text</td>
<td>Standard ID</td>
</tr>
<tr>
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</tr>
<tr>
<td>Identify the effect on the graph of replacing ( f(x) ) by ( f(x) + k ), ( kf(x) ), ( f(kx) ), and ( f(x + k) ) for specific values of ( k ) (both positive and negative). Without technology, find the value of ( k ) given the graphs of linear and quadratic functions. With technology, experiment with cases and illustrate an explanation of the effects on the graph that include cases where ( f(x) ) is a linear, quadratic, piecewise linear (to include absolute value), or exponential function.</td>
<td>A1:F-BF.B.3</td>
</tr>
<tr>
<td>Recognize that sequences are functions whose domain is a subset of the integers. Relate arithmetic sequences to linear functions and geometric sequences to exponential functions.</td>
<td>A1:F-IF.A.3</td>
</tr>
<tr>
<td>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.</td>
<td>A1:F-IF.B.5</td>
</tr>
<tr>
<td>Calculate and interpret the average rate of change of a linear, quadratic, piecewise linear (to include absolute value), and exponential function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.</td>
<td>A1:F-IF.B.6</td>
</tr>
<tr>
<td>Graph piecewise linear (to include absolute value) and exponential functions.</td>
<td>A1:F-IF.C.7.b</td>
</tr>
<tr>
<td>Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.</td>
<td>A1:F-LE.A.1.c</td>
</tr>
<tr>
<td>Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).</td>
<td>A1:F-LE.A.2</td>
</tr>
<tr>
<td>Interpret the parameters in a linear, quadratic, or exponential function in terms of a context.</td>
<td>A1:F-LE.B.5</td>
</tr>
<tr>
<td>Determine an explicit expression, a recursive process, or steps for calculation from a context.</td>
<td>A1:F-BF.A.1.a</td>
</tr>
</tbody>
</table>
# Unit 6 Pacing Guide

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
</table>
| **Exponential Growth Functions** | - Identify an exponential growth function given tables, graphs, and function rules, determining the rate of change.  
  - Graph an exponential growth function, and state the domain and range.  
  - State the domain and range of an exponential growth function.  
  - Write an exponential growth function to model a real-world problem, pointing out constraints in the modeling context. | A1:A-CED.A.2  
  A1:A-REI.D.11  
  A1:F-IF.B.5  
  A1:F-IF.B.6  
  A1:F-LE.A.1.c  
  A1:F-LE.A.2  
  A1:F-IF.C.7.b | 2 |
| **Exponential Decay Functions** | - Identify an exponential decay function given tables, graphs, and function rules, determining the rate of change.  
  - Graph an exponential decay function, and state the domain and range.  
  - Write an exponential decay function to model a real-world problem, pointing out constraints in the modeling context.  
  - Relate exponential growth and decay functions using laws of exponents and reflections over the y-axis. | A1:A-CED.A.2  
  A1:F-IF.B.5  
  A1:F-IF.B.6  
  A1:F-LE.A.1.c  
  A1:F-LE.A.2  
  A1:F-IF.C.7.b | 2 |
| **Vertical Stretches and Shrinks of Exponential Functions** | - Graph a vertically dilated exponential growth or decay function given a table, equation, or scenario.  
  - Determine the parameters and create an equation for a vertically dilated exponential growth or decay function given a table, equation, or scenario. | A1:A-CED.A.1  
  A1:A-CED.A.2  
  A1:F-LE.A.2  
  A1:F-LE.B.5  
  A1:F-IF.C.7.b  
  A1:F-BF.B.3 | 1.5 |
| **Reflections of Exponential Functions** | - Graph reflections of exponential functions.  
  - Analyze key aspects of exponential functions that have been reflected across an axis. | A1:F-IF.B.5  
  A1:F-IF.C.7.b  
  A1:F-BF.B.3 | 1.5 |
| **Translations of Exponential Functions** | - Graph translations of exponential functions.  
  - Analyze key aspects of exponential functions that have been translated. | A1:F-IF.B.5  
  A1:F-IF.C.7.b  
  A1:F-BF.B.3 | 1.5 |
### Lesson Objectives

**Exponential Functions with Radical Bases**
- Simplify and evaluate exponential expressions having whole number bases and fractional exponents.
- Transform expressions in radical form to exponential form and vice versa.
- Determine the key aspects of an exponential function having a radical base by rewriting it using the properties of exponents.

**Rewriting Exponential Functions**
- Write exponential functions and expressions in equivalent forms, using the properties of exponents to justify steps.
- Use alternative forms of an exponential function to highlight different information about that function and the real-world situation it models.

**Geometric Sequences**
- Write recursive and explicit rules for geometric sequences using function notation.
- Graph and analyze geometric sequences as a special case of exponential functions with the domain restricted to natural numbers.

### Standards

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
</tr>
</thead>
</table>
| Exponential Functions with Radical Bases | • Simplify and evaluate exponential expressions having whole number bases and fractional exponents.  
• Transform expressions in radical form to exponential form and vice versa.  
• Determine the key aspects of an exponential function having a radical base by rewriting it using the properties of exponents. | A1:A-SSE.B.3.c |
| Rewriting Exponential Functions | • Write exponential functions and expressions in equivalent forms, using the properties of exponents to justify steps.  
• Use alternative forms of an exponential function to highlight different information about that function and the real-world situation it models. | A1:A-CED.A.1  
A1:A-SSE.B.3.c |
| Geometric Sequences | • Write recursive and explicit rules for geometric sequences using function notation.  
• Graph and analyze geometric sequences as a special case of exponential functions with the domain restricted to natural numbers. | A1:F-IF.A.3  
A1:F-LE.A.2  
A1:F-BF.A.1.a |

### Number of Days

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exponential Functions with Radical Bases</td>
<td></td>
<td>A1:A-SSE.B.3.c</td>
<td>1.5</td>
</tr>
</tbody>
</table>
| Rewriting Exponential Functions | | A1:A-CED.A.1  
A1:A-SSE.B.3.c | 1.5 |
| Geometric Sequences | | A1:F-IF.A.3  
A1:F-LE.A.2  
A1:F-BF.A.1.a | 1.5 |

### Discussion Questions & Answers

1. Compare and contrast exponential growth and decay functions.
   
   a. *A function with exponential growth has output values that increase as the input values increase, and the growth rate is \(1 + \text{percent growth}\). A function with exponential decay has output values that decrease as the input values increase, and the growth rate is \(1 - \text{percent decay}\). Both exponential growth and decay functions have an initial value when the input value is 0.*

2. How are geometric sequences related to exponential functions?
   
   a. *Geometric sequences have a multiplicative rate of change just like exponential functions. However, the domain for geometric sequences is the set of natural numbers and the domain of exponential functions is the set of all real numbers.*

3. How are the rates of change for linear and exponential functions similar? How are they different?
   
   a. *Linear and exponential functions both have a constant rate of change. The rate of change of a linear function is a constant additive rate of change called the slope. The rate of change of an exponential function is a constant multiplicative rate of change called the growth or decay rate.*
Common Misconceptions

- Laws of exponents
  - Students incorrectly apply exponent laws (e.g., they multiply exponents instead of adding them) due to a lack of understanding where the laws come from.

- Horizontal shifts
  - Students shift functions incorrectly when a constant is added or subtracted from the input value (e.g., \( f(x + c) \) shifts left, not right, and \( f(x - x) \) shifts right, not left).

Classroom Challenge

Consider the geometric sequence, \( s_n = 81 \left(\frac{1}{3}\right)^{n-1} \) and the function \( f(x) = 243 \left(\frac{1}{3}\right)^x \). Graph both the sequence and the function. What are the similarities for \( s_n \) and \( f(x) \)? What are the differences?

Possible solution pathway:

![Graphs of geometric sequence and function](image)

Both the sequence and the function have a rate of change of \( \frac{1}{3} \) and an initial value of 243. The domain for the geometric sequence is the set of natural numbers, so the graph is just a group of points. The domain for the function is all real numbers, so the graph is a curve.

Teacher notes:

Struggling students might not consider the domain of the sequence and should be directed to recall the values used for \( n \). Encourage students to set up a table of values and to consider the domain for both relationships.
Advanced students should further explore the values of the formulas without specific values:

\[ s_n = s_1(r)^{n-1} \text{ and } f(x) = ab^x. \]

Have students consider the similarities between the two relationships in terms of initial values and rates of change for both growth and decays.

**UNIT 7: POLYNOMIAL EXPRESSIONS & UNIT 8: POLYNOMIAL EXPRESSIONS (CONTINUED)**

*Estimated Unit Time: Approximately 25 Class Periods—Unit 7 = 13 Class Periods; Unit 8 = 12 Class Periods*

Polynomial Expressions and its continuation are focused solely on major work. The unit begins with a suite of lessons addressing polynomial operations, helping students understand that polynomials form a system analogous to the integers. This major concept builds off of students’ grade 6 work using properties of operations to generate equivalent expressions (MP7); their grade 7 work applying properties of operations as strategies to manipulate linear expressions with multiple grouping symbols; and their grade 8 work using properties of integer exponents to produce equivalent expressions (MP7). Additionally, students advance from the middle school topics of writing, reading, and evaluating expressions with variables and understanding how quantities are related to these expressions by interpreting parts of an expression and viewing one or more parts of a complicated expression as a single entity (MP7). Finally, the teachers coach students in using the structure of an expression to identify ways to rewrite it (MP7)—again building on the grade 6, 7, and 8 topics mentioned above. Students apply these skills to factoring polynomials, including special cases, using a variety of methods.

**Unit 7 & Unit 8 Focus Standards**

The following focus standards are intended to guide teachers to be purposeful and strategic in both what to include and what to exclude when teaching this unit. Although each unit emphasizes certain standards, students are exposed to a number of key ideas in each unit, and as with every rich classroom learning experience, these standards are revisited throughout the course to ensure that students master the concepts with an ever-increasing level of rigor.

In the following table, green highlights indicate major work of the grade, blue highlights indicate supporting work, and yellow highlights indicate additional work.

<table>
<thead>
<tr>
<th>Standard Text</th>
<th>Standard ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>A1:A-APR.A.1</td>
</tr>
<tr>
<td>Interpret parts of an expression, such as terms, factors, and coefficients.</td>
<td>A1:A-SSE.A.1.a</td>
</tr>
<tr>
<td>Interpret complicated expressions by viewing one or more of their parts as a single entity. <em>For example, interpret P(1+r)n as the product of P and a factor not depending on P.</em></td>
<td>A1:A-SSE.A.1.b</td>
</tr>
</tbody>
</table>
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 \((x^2 - y^2)(x^2 + y^2)\), or see \(2x^2 + 8x\) as \(2x(x) + 2x(4)\), thus recognizing it as a polynomial whose terms are products of monomials and the polynomial can be factored as \(2x(x+4)\).

### Unit 7 Pacing Guide

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Polynomials</td>
<td>• Identify a polynomial and its equivalent forms.</td>
<td>A1:A-APR.A.1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>• Classify a polynomial by degree and number of terms.</td>
<td>A1:A-SSE.A.1.a</td>
<td></td>
</tr>
<tr>
<td>Adding and Subtracting Polynomials</td>
<td>• Add and subtract polynomials, determining the degree and number of terms of the sum or difference.</td>
<td>A1:A-APR.A.1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>• Find and evaluate polynomial sums or differences that model real-world situations.</td>
<td>A1:A-SSE.A.1.a</td>
<td></td>
</tr>
<tr>
<td>Multiplying Monomials and Binomials</td>
<td>• Multiply a binomial by a monomial or binomial algebraically and by using geometric models.</td>
<td>A1:A-APR.A.1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>• Identify a product that results in the difference of squares or a perfect square trinomial.</td>
<td>A1:A-SSE.A.1.a</td>
<td></td>
</tr>
<tr>
<td>Multiplying Polynomials and Simplifying Expressions</td>
<td>• Multiply a binomial by a trinomial algebraically and by using geometric models.</td>
<td>A1:A-APR.A.1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>• Interpret the structure of an expression involving addition, subtraction, and multiplication of polynomials in order to write it as a single polynomial in standard form.</td>
<td>A1:A-SSE.A.1.a</td>
<td></td>
</tr>
<tr>
<td>Factoring Polynomials: GCF</td>
<td>• Determine the greatest common monomial factor of two or more terms.</td>
<td>A1:A-SSE.A.1.a</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>• Write a polynomial as the product of a monomial and polynomial having the same number of terms.</td>
<td>A1:A-SSE.A.1.b</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Determine an appropriate way to factor a polynomial for a given context.</td>
<td>A1:A-SSE.A.2</td>
<td></td>
</tr>
<tr>
<td>Factoring Polynomials: Double Grouping</td>
<td>• Factor a polynomial by double grouping or indicate that the polynomial is prime.</td>
<td>A1:A-SSE.A.1.a</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A1:A-SSE.A.2</td>
<td></td>
</tr>
<tr>
<td>Unit Test</td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
Unit 8 Pacing Guide

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
</table>
| Factoring Trinomials: \(a = 1\)      | • Determine if a trinomial with a leading coefficient of 1 and a positive constant is factorable and, if so, write it in factored form.  
   • Relate the factorization of a trinomial with a leading coefficient of 1 and a positive constant to a geometric model.                        | A1:A-SSE.A.2       | 1.5            |
| Factoring Trinomials: \(a = 1\)      | (Continued)  
   • Determine if a trinomial with a leading coefficient of 1 and a negative constant is factorable and, if so, write it in factored form.  
   • Relate the factorization of a trinomial with a leading coefficient of 1 and a negative constant to a geometric model.                   | A1:A-SSE.A.2       | 1.5            |
| Factoring Trinomials: \(a > 1\)      | • Determine if a trinomial with a leading coefficient greater than 1 is factorable and, if so, write it in factored form.  
   • Relate the factorization of a trinomial with a leading coefficient greater than 1 to a geometric model.                                 | A1:A-SSE.A.2       | 2              |
| Factoring Polynomials: Difference of Squares | • Identify a monomial that is a perfect square and find the square root.  
   • Determine if a polynomial is factorable by recognizing that it is a difference of two squares and, if so, applying the identity.                 | A1:A-SSE.A.2       | 2              |
| Factoring Polynomials: Sum and Difference of Cubes | • Identify a monomial that is a perfect cube and find the cube root.  
   • Determine if a polynomial is factorable by recognizing that it is a sum or difference of two cubes and, if so, applying the identity.              | A1:A-SSE.A.2       | 2              |
| Factoring Polynomials Completely     | • Analyze the structure of a polynomial to write it in completely factored form.                                                                                                                             | A1:A-SSE.A.2       | 2              |
| Unit Test                            |                                                                                                                                                                                                            |                    | 1              |

Discussion Questions & Answers

1. What are the defining characteristics of polynomials? What type of numbers can be used for the coefficient? The exponents?
   a. *Polynomials are expressions that have whole number exponents on any variable terms.*  
      They can have one or more terms and still be considered a polynomial.
   b. *The coefficients of a polynomial can be any real number.*
c. The exponents of a polynomial can only be positive whole numbers.

2. What are like terms and how can you identify them?
   a. Like terms are constant terms or variable terms that have the same variable raised to the same power. They are identified by the variable (or lack thereof) and the exponent on the variable.

3. Explain why \((x + 2)^2 \neq x^2 + 4\).
   a. Exponents do not distribute across addition or subtraction. The quantity needs to be multiplied by itself. That is:
      \[
      (x + 2)^2 = (x + 2)(x + 2) = x^2 + 4x + 4
      \]

4. How is performing operations on polynomials different from performing operations with real numbers?
   a. Polynomials can be added, subtracted, multiplied, and divided. However, unlike real number operations, only like terms can be added and subtracted. In addition, when variable terms are multiplied or divided, the exponent on the variable changes.

5. Why do you check for a greatest common factor before trying any factoring method?
   a. There are some polynomials where the GCF is the only number or variable that can be factored out. Otherwise, factoring out the GCF first will make factoring the remaining polynomial easier.

6. How can you determine if a trinomial is factorable?
   a. A trinomial with a leading coefficient of 1 is factorable if there are two numbers that multiply to give the constant term and also add to give the middle coefficient. A trinomial with a leading coefficient other than 1 is factorable if there are two numbers that multiply to give the product of the leading term and the constant term, and those two numbers also add to give the middle coefficient.

7. What does it mean for a polynomial to be factored completely?
   a. A factored polynomial is one that cannot be simplified further by factoring out a GCF or broken down into a product of polynomials to less powers than the original polynomial. In other words, all factors are prime when a polynomial is factored completely.

Common Misconceptions

- Distributive property
  - Students incorrectly apply the distributive property, not attending to the fact that it is multiplication over addition or subtraction.
    - For example, given \(2(xy)\), students multiply 2 to \(x\) and 2 to \(y\).
  - Students forget to change all the signs of the terms when subtracting a quantity or distributing/factoring a negative number.
- Exponents on variables
  - Students incorrectly change the exponent on like terms being summed (2x + 3x = 5x^2).

- Distribution of exponents
  - Students will try to distribute exponents and roots (e.g., when \((x + 2)^2\) becomes \(x^2 + 4\)).

**Classroom Challenges**

Choose four consecutive positive even integers. Multiply the first and last numbers together. Multiply the middle pair together. Subtract the smaller product from the larger product. Repeat this process with additional sets of numbers. Can you explain why the difference is always 8?

**Possible solution pathway:**

Students may represent the integers as \(x, x + 2, x + 4,\) and \(x + 6\).

Multiplying:

\[
x(x + 6) = x^2 + 6x \\
(x + 2)(x + 4) = x^2 + 6x + 8
\]

Subtracting:

\[
(x^2 + 6x + 8) - (x^2 + 6x) = 8 \\
8 = 8
\]

Since \(x\) represents any positive even integer, this works for all sets of four consecutive positive even integers.

**Teacher notes:**

Struggling students will need help translating the words into polynomial expressions. Point out that the goal is to show the difference of the two products should equal 8.

Advanced students should determine how the problem would change if the numbers were consecutive even numbers.

- Find two positive integers such that \(a^2 - b^2 = 99\).

**Possible solution pathway:**

Students may utilize the fact that \(a^2 - b^2 = (a - b)(a + b)\) and the factors of 99 are 1, 3, 9, 11, and 99.

Using 1 and 99 as factors, \((a - b)(a + b) = (50 - 49)(50 + 49)\).

The numbers are 50 and 49.
Teachers notes:

Struggling students may be intimidated by two variables. Remind them what the factors of 99 are, and that \((a - b)\) has to be one of those factors and \((a + b)\) has to be another.

Advanced students should try to see if this can be done with \(a^4 - b^4\) and explain why or why not.

UNIT 9: QUADRATIC FUNCTIONS

Estimated Unit Time: Approximately 16 Class Periods

In Unit 9, students learn another brand-new function: quadratic. The unit begins by reminding students what it means for a relationship to be a function (a topic students should be familiar with now that they have learned it in 8th grade and earlier in Algebra I), and then launches into the unique aspects of quadratic functions. Students learn standard, factored, and vertex forms. Covering all forms, students use the structure of an expression to identify ways to rewrite quadratic functions (MP7), converting between forms, and giving special attention to completing the square to do so. They also attend to modeling when they learn to create quadratic equations arising from quadratic functions in one and two variables (MP4). As students learn to solve these advanced modeling problems, the on-screen teachers encourage students to employ the problem-solving process to make sense of these problems and persevere in completing them (MP1). A performance task ties it all together to conclude the unit, incorporating several practice standards (MP3, MP4, and MP7) within the content standards covered in this project.

Unit 9 Focus Standards

The following focus standards are intended to guide teachers to be purposeful and strategic in both what to include and what to exclude when teaching this unit. Although each unit emphasizes certain standards, students are exposed to a number of key ideas in each unit, and as with every rich classroom learning experience, these standards are revisited throughout the course to ensure that students master the concepts with an ever-increasing level of rigor.

In the following table, green highlights indicate major work of the grade, blue highlights indicate supporting work, and yellow highlights indicate additional work.

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<tbody>
<tr>
<td>Identify zeros of quadratic functions, and use the zeros to sketch a graph of</td>
<td>A1:A-APR.B.3</td>
</tr>
<tr>
<td>the function defined by the polynomial.</td>
<td></td>
</tr>
<tr>
<td>Create equations and inequalities in one variable and use them to solve</td>
<td>A1:A-CED.A.1</td>
</tr>
<tr>
<td>problems. Include equations arising from linear, quadratic, and exponential</td>
<td></td>
</tr>
<tr>
<td>functions.</td>
<td></td>
</tr>
<tr>
<td>Create equations in two or more variables to represent relationships between</td>
<td>A1:A-CED.A.2</td>
</tr>
<tr>
<td>quantities; graph equations on coordinate axes with labels and scales.</td>
<td></td>
</tr>
<tr>
<td>Standard Text</td>
<td>Standard ID</td>
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<tr>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>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.</td>
<td>A1:A-REI.A.1</td>
</tr>
<tr>
<td>Interpret parts of an expression, such as terms, factors, and coefficients.</td>
<td>A1:A-SSE.A.1.a</td>
</tr>
<tr>
<td>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) ), or see ( 2x^2 + 8x ) as ( 2x(x) + 2x(4) ), thus recognizing it as a polynomial whose terms are products of monomials and the polynomial can be factored as ( 2x(x+4) ).</td>
<td>A1:A-SSE.A.2</td>
</tr>
<tr>
<td>Factor a quadratic expression to reveal the zeros of the function it defines.</td>
<td>A1:A-SSE.B.3.a</td>
</tr>
<tr>
<td>Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.</td>
<td>A1:A-SSE.B.3.b</td>
</tr>
<tr>
<td>Identify the effect on the graph of replacing ( f(x) ) by ( f(x) + k, kf(x), f(kx) ), and ( f(x + k) ) for specific values of ( k ) (both positive and negative). Without technology, find the value of ( k ) given the graphs of linear and quadratic functions. With technology, experiment with cases and illustrate an explanation of the effects on the graph that include cases where ( f(x) ) is a linear, quadratic, piecewise linear (to include absolute value), or exponential function.</td>
<td>A1:F-BF.B.3</td>
</tr>
<tr>
<td>For linear, piecewise linear (to include absolute value), quadratic, and exponential functions that model 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. <strong>Key features include:</strong> intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.</td>
<td>A1:F-IF.B.4</td>
</tr>
<tr>
<td>Calculate and interpret the average rate of change of a linear, quadratic, piecewise linear (to include absolute value), and exponential function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.</td>
<td>A1:F-IF.B.6</td>
</tr>
<tr>
<td>Graph linear and quadratic functions and show intercepts, maxima, and minima.</td>
<td>A1:F-IF.C.7.a</td>
</tr>
<tr>
<td>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.</td>
<td>A1:F-IF.C.8.a</td>
</tr>
<tr>
<td>Interpret the parameters in a linear, quadratic, or exponential function in terms of a context.</td>
<td>A1:F-LE.B.5</td>
</tr>
</tbody>
</table>
## Unit 9 Pacing Guide

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
</table>
| **Introduction to Quadratic Functions** | - Identify a quadratic function and the values of the coefficients and constant from the standard form.  
- Evaluate a quadratic function using tables, graphs, and equations.  
- Calculate the rate of change of a quadratic function over an interval of its domain, and compare it to linear and exponential functions. | A1:A-SSE.A.1.a  
A1:F-IF.B.6                                  | 2              |
| **Quadratic Functions: Standard Form** | - Graph a quadratic function given in standard form, identifying the key features of the graph.                                                                                   | A1:A-APR.B.3  
A1:A-SSE.B.3.a  
A1:F-IF.C.7.a                                  | 1.5               |
| **Quadratic Functions: Factored Form** | - Graph a quadratic function given in factored form, identifying the key features of the graph.                                                                                         | A1:A-APR.B.3  
A1:A-SSE.B.3.a  
A1:F-IF.C.7.a                                  | 1.5               |
| **Quadratic Functions: Vertex Form** | - Graph a quadratic function given in vertex form, identifying the key features of the graph.  
- Relate the parameters of a quadratic function in vertex form to transformations of the graph \( y = x^2 \).                                           | A1:F-IF.C.7.a  
A1:F-BF.B.3                                   | 1.5               |
| **Completing the Square**           | - Relate the geometric model of completing the square to the algebraic process.  
- Write quadratic functions given in standard form and with \( a = 1 \) into vertex form by completing the square.  
- Determine key aspects of the graph of a quadratic function given in standard form and with \( a = 1 \) by writing it in vertex form.  
- Relate the parameters of a quadratic function in vertex form to transformations of the graph \( y = x^2 \). | A1:A-SSE.A.2  
A1:A-SSE.B.3.b  
A1:F-IF.C.8.a  
A1:F-BF.B.3                                  | 2              |
| **Completing the Square (Continued)** | - Write quadratic functions given in standard form into vertex form by completing the square.  
- Determine key aspects of the graph of a quadratic function given in standard form by writing it in vertex form.  
- Relate the parameters of a quadratic function in vertex form to transformations of the graph \( y = x^2 \). | A1:A-SSE.A.2  
A1:A-SSE.B.3.b  
A1:F-IF.C.8.a  
A1:F-BF.B.3                                  | 2              |
Lesson | Objectives | Standards | Number of Days
--- | --- | --- | ---
Modeling with Quadratic Functions | • Write quadratic functions to model problems.  
• Use quadratic functions to solve mathematical and real-world problems.  
• Solve equations arising from questions asked about functions that model real-world applications, including quadratic functions tabularly.  
• Solve equations arising from questions asked about functions that model real-world applications, including quadratic functions graphically. | A1:A-CED.A.1  
A1:A-CED.A.2  
A1:F-LE.B.5  
A1:F-IF.C.7.a  
A1:F-IF.C.8.a | 2
Performance Task: Daredevil Danny | | A1:A-REI.A.1  
A1:A-CED.A.1  
A1:A-CED.A.2  
A1:F-BF.B.3 | 2
Unit Test | | | 1

Discussion Questions & Answers
1. What are the three ways to write a quadratic function? Why would one form be more useful than another?
   a. **The three forms of a quadratic function are:**
      i. **Standard form:** \( f(x) = ax^2 + bx + c; \left( -\frac{b}{2a}, f \left( -\frac{b}{2a} \right) \right) \) is the vertex, \((0, c)\) is the y-intercept
      ii. **Vertex form:** \( f(x) = a(x - h)^2 + k; \) \((h, k)\) is the vertex
      iii. **Factored form:** \( f(x) = a(x - r_1)(x - r_2); \) \(r_1\) and \(r_2\) are the x-intercepts
   b. **One form is more useful than another to find the vertex, y-intercept, or x-intercept(s) if they exist (solutions).**
2. What are key characteristics used to graph a quadratic function?
   a. **A graph of a quadratic function should include the vertex, the y-intercept, the x-intercept(s) (if they exist), symmetry of the graph, and intervals of increase/decrease and positive/negative**
3. How can you rewrite a quadratic function in a different form? Standard to vertex? Vertex to standard? Standard to factored? Factored to standard?
   a. **Rewriting a quadratic function in different forms requires multiplication, factoring, or completing the square.**
      i. **Standard to vertex:** complete the square for the polynomial
      ii. **Vertex to standard:** multiply out the squared quantity and combine like terms
      iii. **Standard to factored:** factor the polynomial
iv. *Factored to standard: multiply out the two quantities and combine like terms*

Common Misconceptions

- Distribution of exponents
  - Students will try to distribute exponents and roots (e.g., \((x + 2)^2 = x^2 + 4\) or \(\sqrt{x^2 - 9} = x - 3\)).

Classroom Challenge

Consider output values for the function \(f(x) = x^2\). Describe the rate of change of the graph over the following intervals: (0, 1), (1, 2), (2, 3), (3, 4), and (4, 5).

- What do you notice about the rates of change?
- Can you use algebra to explain the pattern?
- Does this pattern hold true for other quadratic functions with a leading coefficient of 1?
- What happens to the rate of change when there is a positive integer coefficient on \(x\) squared?
- How can you use the rate of change to graph a quadratic function whose leading coefficient is an integer?

Possible solution pathway:

Students may use a table or graph to calculate the rates of change over each interval.

<table>
<thead>
<tr>
<th>(x)</th>
<th>(f(x))</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>25</td>
</tr>
</tbody>
</table>

Students should recognize that to the right of 0 as \(x\)-values increase by 1, the output values increase by 1, then 3, then 5, then 7, and so on.

Students may use specific cases to examine the pattern, such as:

\[
(x + 1)^2 = x^2 + 2x + 1 \\
(x + 2)^2 = x^2 + 4x + 4 \\
(x + 3)^2 = x^2 + 6x + 9 \\
(x + 4)^2 = x^2 + 8x + 16
\]
They may see the pattern in the constant terms, but not be able to account for how the change in the middle term affects the output values.

Subtracting consecutive outputs, we get \(2x + 1, 2x + 3, 2x + 5, 2x + 7,\) and so on. Since the expressions all contain \(2x,\) the middle term’s value has no impact on the overall change in the output values.

Placing a coefficient on \(x^2\) multiplies the rate of change by that value. Therefore, for \(2x^2,\) the pattern is 2, 6, 10, 14, and so on. For \(3x^2,\) the pattern is 3, 9, 15, 21, and so on.

To graph a quadratic function whose leading coefficient is an integer, locate the vertex and use the pattern in the rate of change to plot other points on the curve. Due to symmetry, this same pattern exists to the left of 0 with each decrease by 1 in the \(x\)-values.

Teacher notes:

Encourage struggling students to make a table of the inputs and outputs. Have them find the difference between each output and have them try to find a pattern in these differences. Suggest that they use numbers instead of variables to find patterns.

Advanced students could try to explain why the second differences of the output values are all 2.

UNIT 10: ANALYZING RELATIONSHIPS

Estimated Unit Time: Approximately 11 Class Periods

Unit 10 develops advanced abstract and quantitative reasoning skills (MP2). Students focus on using function notation, relating domains to graphical representations, and calculating and interpreting rate of change in Analyzing Relationships. In particular, students practice these skills on a number of functions: quadratic, exponential, and linear piecewise-defined—including step and absolute value functions. This unit is particularly strong in expanding students’ 8th grade work in qualitatively describing functional relationships between two quantities by analyzing graphs and sketching qualitative graphs based on verbal descriptions. Students now interpret key features of graphs and tables in terms of the quantities they model and sketch quantitative graphs given verbal descriptions of relationships. Finally, students analyze the growth of linear, exponential, and quadratic functions.

Unit 10 Focus Standards

The following focus standards are intended to guide teachers to be purposeful and strategic in both what to include and what to exclude when teaching this unit. Although each unit emphasizes certain standards, students are exposed to a number of key ideas in each unit, and as with every rich classroom learning experience, these standards are revisited throughout the course to ensure that students master the concepts with an ever-increasing level of rigor.

In the following table, green highlights indicate major work of the grade, blue highlights indicate supporting work, and yellow highlights indicate additional work.
<table>
<thead>
<tr>
<th>Standard Text</th>
<th>Standard ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.</td>
<td>A1:F-IF.A.2</td>
</tr>
<tr>
<td>Recognize that sequences are functions whose domain is a subset of the integers. Relate arithmetic sequences to linear functions and geometric sequences to exponential functions.</td>
<td>A1:F-IF.A.3</td>
</tr>
<tr>
<td>For linear, piecewise linear (to include absolute value), quadratic, and exponential functions that model 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; and end behavior.</td>
<td>A1:F-IF.B.4</td>
</tr>
<tr>
<td>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.</td>
<td>A1:F-IF.B.5</td>
</tr>
<tr>
<td>Calculate and interpret the average rate of change of a linear, quadratic, piecewise linear (to include absolute value), and exponential function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.</td>
<td>A1:F-IF.B.6</td>
</tr>
<tr>
<td>Graph piecewise linear (to include absolute value) and exponential functions.</td>
<td>A1:F-IF.C.7.b</td>
</tr>
<tr>
<td>Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.</td>
<td>A1:F-LE.A.1.a</td>
</tr>
<tr>
<td>Observe, using graphs and tables, that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.</td>
<td>A1:F-LE.A.3</td>
</tr>
</tbody>
</table>
## Unit 10 Pacing Guide

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
</table>
| Linear Piecewise Defined Functions        | • Relate the graph of a piecewise-defined function to its algebraic representation, limiting it to linear functions over its domain.  
  • Evaluate a piecewise-defined function that is defined by linear functions over all intervals of its domain.  
  • Graph a piecewise-defined function that is defined by linear functions over all intervals of its domain.  
  • State the domain and range of linear piecewise-defined functions.                                                                                     | A1:F-IF.A.2  
  A1:F-IF.B.5  
  A1:F-IF.B.6  
  A1:F-IF.C.7.b | 2                                                          |
| Step Functions                             | • Interpret a step function in terms of the problem it models.  
  • Evaluate a step function.  
  • Graph a step function.  
  • State the domain and range of step functions.                                                                                                        | A1:F-IF.A.2  
  A1:F-IF.B.4  
  A1:F-IF.B.5  
  A1:F-IF.C.7.b | 2                                                          |
| Recognizing Patterns                       | • Analyze a sequence of numbers to determine the pattern, and identify whether it is arithmetic or geometric.  
  • Use a recursive rule to calculate a term of a sequence.  
  • Write a recursive rule for a sequence.                                                                                                                | A1:F-IF.A.2  
  A1:F-IF.A.3 | 2                                                          |
| Linear Growth vs. Exponential Growth      | • Use tables and graphs to compare the growth of an exponential function vs. a linear function over equal intervals.  
  • Use tables and graphs to show that exponential functions grow by equal factors over equal intervals.                                                | A1:F-LE.A.1.a  
  A1:F-LE.A.3 | 1                                                          |
| Comparing Exponential, Linear, and Quadratic Growth | • Use tables and graphs to compare the growth of an exponential function to the growth of a linear function over equal intervals.  
  • Use tables and graphs to compare the growth of an exponential function to the growth of a quadratic or a polynomial function over equal intervals.  
  • Use tables and graphs to show that exponential functions grow by equal factors over equal intervals.                                      | A1:F-LE.A.1.a  
  A1:F-LE.A.3  
  A1:F-IF.B.6 | 1                                                          |
| Analyzing Functional Relationships         | • Interpret key features of a function represented graphically in terms of a real-world context.  
  • Interpret key features of a function represented tabularly in terms of a real-world context.  
  • Graph a function given a verbal description of a relationship.                                                                                     | A1:F-IF.B.4  
  A1:F-IF.B.6 | 2                                                          |
| Unit Test                                 |                                                                                                                                             |                                        | 1                                                          |
Discussion Questions & Answers

1. How do real-world contexts affect the domain and range of functions?
   a. Real-world contexts can limit the domain and range of functions that would normally not be restricted. For example, when time is the independent quantity, negative values do not usually make sense, and when heights are the dependent quantity, negative values do not usually make sense.

2. How do step functions differ from piecewise functions? How are step functions similar to piecewise functions?
   a. Piecewise functions are represented by a combination of equations, each corresponding to a different part of the domain. A step function consists of different constant range values for different intervals of the domain of the function. A step function is a special type of piecewise function; both types of functions must have non-overlapping intervals of their domains.

3. How does the growth of increasing linear, quadratic, and exponential functions compare to each other?
   a. Comparing the growth of increasing linear, quadratic, and exponential functions will show that the growth of a linear function is the slowest, having an additive rate of change, while the growth of the exponential function is the fastest, having a multiplicative rate of change.

Common Misconceptions

- Quantitative reasoning
  o Students think graphs are literal pictures of a situation.

- Piecewise function
  o Students may think that a function must be defined by a single rule; therefore, if there is more than one rule, then the relation is not a function.

Classroom Challenge

Create a graph with the following components:

- An increasing, additive rate of change over the interval \([-\infty, -4]\)
- A rate of change of 0 over the interval \([-3, 5]\)
- A decreasing, multiplicative rate of change over the interval \([6, \infty]\)
Possible solution pathway:

Graphs will vary, but students should create a linear function with a positive slope for the first piece, a horizontal line for the second piece, and an exponential function for the third piece.

Teacher notes:

Struggling students should be reminded about the rates of change of linear and exponential functions. Encourage students to draw entire graphs for each rate of change and then piece together the graphs over the indicated domains.

Advanced students should attempt to write an equation for their piecewise function graph.

UNIT 11: QUADRATIC EQUATIONS

Estimated Unit Time: Approximately 18 Class Periods

Unit 11, Quadratic Equations, opens by relating quadratic equations to their respective quadratic functions. Students use the graphed quadratic functions to solve quadratic equations by inspection. This unit is also devoted to solving quadratic equations in a variety of ways. Students solve quadratic equations by taking square roots, completing the square, using the quadratic formula, and factoring as appropriate to the initial form of the equation. Students are building off of their 8th-grade knowledge of using square root symbols to represent solutions to equations of the form \( x^2 = p \) (\( p \) being a positive rational number) when they solve quadratic equations by taking square roots. Completing the square is also used to transform quadratic equations into vertex form in this unit (MP7). Students create quadratic equations (MP4) to solve problems (MP2) in mathematical and modeling contexts, interpreting their solutions in the context of the problem (MP2). As these quadratic modeling tasks are often challenging and require multiple steps, students are encouraged to use the problem-solving process to make sense of these tasks and persevere in solving them (MP1).
Unit 11 Focus Standards

The following focus standards are intended to guide teachers to be purposeful and strategic in both what to include and what to exclude when teaching this unit. Although each unit emphasizes certain standards, students are exposed to a number of key ideas in each unit, and as with every rich classroom learning experience, these standards are revisited throughout the course to ensure that students master the concepts with an ever-increasing level of rigor.

In the following table, green highlights indicate major work of the grade, blue highlights indicate supporting work, and yellow highlights indicate additional work.

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<thead>
<tr>
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</tr>
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<tbody>
<tr>
<td>Identify zeros of quadratic functions, and use the zeros to sketch a graph of the function defined by the polynomial.</td>
<td>A1:A-APR.B.3</td>
</tr>
<tr>
<td>Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions.</td>
<td>A1:A-CED.A.1</td>
</tr>
<tr>
<td>Use the method of completing the square to transform any quadratic equation in x into an equation of the form ((x - p)^2 = q) that has the same solutions. Derive the quadratic formula from this form.</td>
<td>A1:A-REI.B.4.a</td>
</tr>
<tr>
<td>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 &quot;no real solution.&quot;</td>
<td>A1:A-REI.B.4.b</td>
</tr>
<tr>
<td>Factor a quadratic expression to reveal the zeros of the function it defines.</td>
<td>A1:A-SSE.B.3.a</td>
</tr>
<tr>
<td>Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.</td>
<td>A1:N-RN.B.3</td>
</tr>
</tbody>
</table>

Unit 11 Pacing Guide

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quadratic Equations and their Related Functions</td>
<td>• Relate the solutions of a quadratic equation to the x-intercepts of the related quadratic function, and use the function's graph to solve the equation.</td>
<td>A1:A-APR.B.3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A1:A-REI.B.4.b</td>
<td></td>
</tr>
<tr>
<td>Lesson</td>
<td>Objectives</td>
<td>Standards</td>
<td>Number of Days</td>
</tr>
<tr>
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<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>----------------</td>
</tr>
</tbody>
</table>
| Solving Quadratic Equations: Factoring      | • Write a quadratic equation that models a scenario.  
• Solve problems by rewriting quadratic equations in standard form and factoring, pointing out the solutions that are viable or not viable in a modeling context.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | A1:CED.A.1, A1:REI.B.4.b, A1:SSE.B.3.a                                                                                                                                                                                                                       | 1.5             |
| Operations on Rational and Irrational Numbers | • Explain why the sum and product of two rational numbers are rational.  
• Explain why the sum of a rational number and an irrational number is irrational.  
• Explain why the product of a nonzero rational number and an irrational number is irrational.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | A1:RN.B.3                                                                                                                                                                                                                                                  | 1               |
| Solving Quadratic Equations: Square Root Property | • Use the square root property to solve quadratic equations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | A1:REI.B.4.b                                                                                                                                                                                                                                                | 2               |
| Solving Quadratic Equations: Completing the Square | • Solve a quadratic equation whose leading coefficient is 1 by completing the square.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | A1:REI.B.4.a, A1:REI.B.4.b                                                                                                                                                                                                                                        | 1.5             |
| Solving Quadratic Equations: Completing the Square (Continued) | • Solve a quadratic equation whose leading coefficient is greater than 1 by completing the square.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | A1:REI.B.4.a, A1:REI.B.4.b                                                                                                                                                                                                                                        | 1.5             |
| Introduction to the Quadratic Formula       | • Justify the steps used to derive the quadratic formula by completing the square.  
• Determine the values of $a$, $b$, and $c$ from a given quadratic equation in standard form.  
• Recognize an expression that uses the quadratic formula to find the solutions of a quadratic equation.  
• Relate the discriminant in the quadratic formula to the types of solutions of a quadratic equation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | A1:REI.B.4.a, A1:REI.B.4.b                                                                                                                                                                                                                                       | 2               |
| Solving Quadratic Equations: Quadratic Formula | • Solve a quadratic equation using the quadratic formula.  
• Determine the number of real zeros of a quadratic function by finding the values of $a$, $b$, and $c$, and then calculating the discriminant.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | A1:REI.B.4.b                                                                                                                                                                                                                                                | 2               |
### Lesson Objectives

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling with Quadratic Equations</td>
<td>- Write and solve quadratic equations to model real-world scenarios, estimating where appropriate and identifying solutions that are not viable in terms of the context.</td>
<td>A1:A-CED.A.1</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A1:A-REI.B.4.b</td>
<td></td>
</tr>
<tr>
<td>Unit Test</td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

### Discussion Questions & Answers

1. Explain how the discriminant is used to predict the number of solutions of a quadratic equation.
   
   - The quadratic equation must first be in standard form. The discriminant is then calculated. If the value of the discriminant is positive, then the quadratic equation will have two real solutions. If the value of the discriminant is negative, then the quadratic equation will have two complex solutions. If the value of the discriminant is 0, then the quadratic equation will have one real solution.

2. How can you solve a quadratic function that is not factorable?
   
   - You can solve a non-factorable quadratic function by completing the square or using the quadratic formula. In addition, you can get a decimal approximation for the solutions by graphing its related function and estimating the x-intercepts.

3. How are x-intercepts related to the solution of a quadratic equation?
   
   - The x-intercepts of a quadratic function are the solutions to the quadratic equation because they are the x-values when the y-value is 0. If the quadratic equation has complex solutions, the graph will not have x-intercepts.

### Common Misconceptions

- Distribution of exponents
  - Students may try to distribute exponents and roots (e.g., \((x + 2)^2 = x^2 + 4\) or \(\sqrt{x^2 - 9} = x - 3\)).

- Solutions from factored polynomials
  - Students factor to solve and neglect to apply the zero product property (e.g., \(0 = (x - 2)(x + 1)\), so the solutions are incorrectly given as \(x = -2\) and \(x = 1\)).

- Quadratic formula
  - Students may divide the first number by \(2a\) and not the simplified discriminant.
Classroom Challenge

A small neighborhood shares a community garden. Each interested community member is given 4 stakes and 100 feet of fencing to block off a rectangular garden space.

Two of the community members decide to pool their resources and combine their fencing to section off one large space that they will garden together.

Another community member complains, “Hey, that’s not fair! They’re each getting more land to garden! Members should not be allowed to join fencing together.”

Is this complaint valid?

Possible solution pathway:

The perimeter of a small rectangular garden is 100 ft and the perimeter of a larger garden is 200 ft.

Students can write equations for the perimeter:

Small garden: \(2w + 2l = 100\)

Larger garden: \(2w + 2l = 200\)

Solving each equation for \(l\):

Small garden: \(l = 50 - w\)

Larger garden: \(l = 100 - w\)

The area of a rectangle is length multiplied by width, so we have:

Area of small garden = \(w(50 - w)\)

Area of larger garden = \(w(100 - w)\)

We need to compare the areas. We can graph the quadratic equations \(y = x(50 - x)\) and \(y = x(100 - x)\) to analyze the relationship of area with respect to width of the garden.
In analyzing the graphs, we can see that the maximum area with 100 ft of fencing is when the width is 25 ft, or the garden is square. The area is 625 sq ft. When there is 100 ft of fencing, the maximum area is 2,500 sq ft. If the two members split the area evenly, they would each get a 1,250 sq ft garden area, which is more than the 625 sq ft they would have if they just used their 100 ft of fencing. Therefore, the complaint is valid. By combining fencing, members get more land to garden.

Teacher notes:

Have struggling students draw a picture of the fence. Ask them what the sides of the fence add up to, leading them to perimeter.

Advanced students can attempt to find the maximum dimensions of the garden given the constraints.

**UNIT 12: DESCRIPTIVE STATISTICS**

*Estimated Unit Time: Approximately 8 Class Periods*

Descriptive Statistics contains supporting and additional topics focused on engaging students in the major cluster of interpreting models by teaching them to summarize, represent, and interpret data on two categorical and quantitative variables. Students interpret differences in shape, center, and spread of data sets, as well as using statistics appropriate to the data distribution to make critical comparisons of two or more data sets. In previous grades, students learned to simply understand that a data set can be described by its shape, center, and spread, and to summarize data sets using these statistical descriptions. This unit extends those skills by teaching students to compare the statistical measures and interpret the differences between them among two or more data sets. They also work to summarize categorical data in two-way frequency tables, learning joint, marginal, and conditional relative frequencies in the process.
Unit 12 Focus Standards

The following focus standards are intended to guide teachers to be purposeful and strategic in both what to include and what to exclude when teaching this unit. Although each unit emphasizes certain standards, students are exposed to a number of key ideas in each unit, and as with every rich classroom learning experience, these standards are revisited throughout the course to ensure that students master the concepts with an ever-increasing level of rigor.

In the following table, **green highlights** indicate major work of the grade, **blue highlights** indicate supporting work, and **yellow highlights** indicate additional work.

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<thead>
<tr>
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<tbody>
<tr>
<td>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.</td>
<td>A1:S-ID.A.2</td>
</tr>
<tr>
<td>Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).</td>
<td>A1:S-ID.A.3</td>
</tr>
<tr>
<td>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.</td>
<td>A1:S-ID.B.5</td>
</tr>
</tbody>
</table>

Unit 12 Pacing Guide

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
</table>
| Describing Data | • Identify various data collection methods and analyze various displays of data.  
                      • Determine if a sample fairly represents the population as a whole or if there is bias.  
                      • Informally describe the shape, center, and variability of a distribution based on a dot plot, histogram, or box plot. | A1:S-ID.A.3  | 1              |
| Two-Way Tables | • Display data in a two-way frequency table given a scenario or Venn diagram, and identify joint and marginal frequencies.  
                      • Calculate relative frequencies and display them in a two-way relative frequency table.  
                      • Interpret joint and marginal relative frequencies in the context of the data. | A1:S-ID.B.5  | 1.5            |
## Lesson Objectives

<table>
<thead>
<tr>
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</tr>
</thead>
</table>
| Relative Frequencies and Association | • Create conditional relative frequency tables, by row and by column.  
• Interpret conditional relative frequencies in the context of the data.  
• Determine whether there is an association between two variables by analyzing conditional relative frequencies. | A1:S-ID.B.5            | 1.5            |
| Measures of Center             | • Calculate the mean and median for a set of data using technology when appropriate.  
• Compare the mean and median of a set of data that is symmetrical and for a set of data that is not symmetrical, determining which is a better measure of center for a given data set.  
• Create a dot plot or histogram for a set of data.  
• Discuss the effect of outliers on measures of center. | A1:S-ID.A.3            | 1              |
| Standard Deviation             | • Calculate variance and standard deviation for a given data set.  
• Analyze histograms for skewness and symmetry.  
• Analyze a normal distribution curve to determine statistical measures. | A1:S-ID.A.2, A1:S-ID.A.3 | 1              |
| Comparing Data Sets            | • Compare two distributions in terms of center, variability, and shape.  
• Choose which measure of center, measure of variability, and display should be used to describe a data set. | A1:S-ID.A.2, A1:S-ID.A.3 | 1              |

### Discussion Questions & Answers

1. How is a two-way frequency table used to determine if there is an association between the variables?
   
a. There is an association between the two variables of a two-way table if the row (or column) conditional relative frequencies are different for the rows (or columns) of the table. A stronger association is shown by a bigger difference in the conditional relative frequencies.

2. How are joint, marginal, and conditional frequencies related?
   
a. Joint frequency is a ratio of the frequency in a particular row (or column) and the total number of data values, while marginal frequency is a ratio of the sum of the joint relative frequency in a row (or column) and the total number of data values. Conditional
frequency is ratio of a joint relative frequency and related marginal relative frequency of a row (or column).

3. When is the median the preferred measure of center? When is the mode the preferred measure of center?
   a. The median is the best measure of center for skewed distributions.
   b. The mode is the preferred measure of center for nominal data.

4. How do the measures of variation relate to the consistency and spread of a data set?
   a. The range and IQR can show the overall spread of the data set. That is, the larger the range or IQR, the more spread out the data set. The variance and standard deviation indicate how far most of the data is from the average data value. That is, the larger the standard deviation, the more inconsistent the data set in terms of distance from the mean.

Common Misconceptions
- Correlation vs. causation
  o Students automatically assume causation when two quantities show a strong correlation.

Classroom Challenge
Students were surveyed at a local high school about their favorite sport and favorite pet. Use the given joint relative frequencies to complete the two-way table. Determine the possible frequencies for each cell.

<table>
<thead>
<tr>
<th></th>
<th>Soccer</th>
<th>Baseball</th>
<th>Basketball</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat</td>
<td>0.15</td>
<td>0.21</td>
<td>0.21</td>
<td>0.57</td>
</tr>
<tr>
<td>Dog</td>
<td>0.12</td>
<td>0.21</td>
<td>0.16</td>
<td>0.49</td>
</tr>
<tr>
<td>Fish</td>
<td>0.01</td>
<td>0.03</td>
<td>0.01</td>
<td>0.05</td>
</tr>
<tr>
<td>Total</td>
<td>0.28</td>
<td>0.34</td>
<td>0.38</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Possible solution pathway:

<table>
<thead>
<tr>
<th></th>
<th>Soccer</th>
<th>Baseball</th>
<th>Basketball</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat</td>
<td>0.15</td>
<td>0.10</td>
<td>0.21</td>
<td>0.46</td>
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<tr>
<td>Dog</td>
<td>0.12</td>
<td>0.21</td>
<td>0.16</td>
<td>0.49</td>
</tr>
<tr>
<td>Fish</td>
<td>0.01</td>
<td>0.03</td>
<td>0.01</td>
<td>0.05</td>
</tr>
<tr>
<td>Total</td>
<td>0.28</td>
<td>0.34</td>
<td>0.38</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Teacher notes:
Struggling students should be reminded what the rows and columns of the total should add up to, and be encouraged to work backward.
Advanced students should fill out the values of the actual frequencies with a total number of students surveyed being a value other than 100.

**UNIT 13: TRENDS IN DATA**

*Estimated Unit Time: Approximately 11 Class Periods*

Students apply calculating and interpreting slopes and intercepts of functions that model data in Unit 13 (MP4). They also learn to compute (using technology) and interpret the correlation coefficient of a linear fit (MP5). They use function notation in a statistical setting by making predictions in the context of real-world data by interpolation and extrapolation. Finally, students distinguish between correlation and causation, recognizing that correlation does not necessarily imply causation (MP6). These practices build a solid foundation for students to interpret models by fitting functions to mathematical and real-world contexts (MP4).

**Unit 13 Focus Standards**

The following focus standards are intended to guide teachers to be purposeful and strategic in both what to include and what to exclude when teaching this unit. Although each unit emphasizes certain standards, students are exposed to a number of key ideas in each unit, and as with every rich classroom learning experience, these standards are revisited throughout the course to ensure that students master the concepts with an ever-increasing level of rigor.

In the following table, green highlights indicate major work of the grade, blue highlights indicate supporting work, and yellow highlights indicate additional work.

<table>
<thead>
<tr>
<th>Standard Text</th>
<th>Standard ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. <em>For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</em></td>
<td>A1:A-CED.A.3</td>
</tr>
<tr>
<td>Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.</td>
<td>A1:F-IF.A.2</td>
</tr>
<tr>
<td>Calculate and interpret the average rate of change of a linear, quadratic, piecewise linear (to include absolute value), and exponential function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.</td>
<td>A1:F-IF.B.6</td>
</tr>
<tr>
<td>Fit a function to the data; use functions fitted to data to solve problems in the context of the data. <em>Use given functions or choose a function suggested by the context. Emphasize linear and quadratic models.</em></td>
<td>A1:S-ID.B.6.a</td>
</tr>
<tr>
<td>Informally assess the fit of a function by plotting and analyzing residuals.</td>
<td>A1:S-ID.B.6.b</td>
</tr>
<tr>
<td>Fit a linear function for a scatter plot that suggests a linear association.</td>
<td>A1:S-ID.B.6.c</td>
</tr>
<tr>
<td>Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.</td>
<td>A1:S-ID.C.7</td>
</tr>
<tr>
<td>Standard Text</td>
<td>Standard ID</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Compute (using technology) and interpret the</td>
<td>A1:S-ID.C.8</td>
</tr>
<tr>
<td>correlation coefficient of a linear fit.</td>
<td></td>
</tr>
<tr>
<td>Distinguish between correlation and causation.</td>
<td>A1:S-ID.C.9</td>
</tr>
</tbody>
</table>

### Unit 13 Pacing Guide

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
<th>Standards</th>
<th>Number of Days</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction to Modeling with Functions</strong></td>
<td>• Analyze a data set to determine a linear, quadratic, or exponential</td>
<td>A1:F-IF.B.6&lt;br&gt; A1:S-ID.B.6.a&lt;br&gt; A1:S-ID.B.6.c</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>function to model it.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Line of Best Fit</strong></td>
<td>• Determine if a data set shows a correlation and, if so, the type of</td>
<td>A1:F-IF.A.2&lt;br&gt; A1:S-ID.C.7&lt;br&gt; A1:F-IF.B.6&lt;br&gt; A1:S-ID.B.6.a&lt;br&gt; A1:S-ID.B.6.c</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>correlation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Use technology to determine the line of best fit for a data set, and</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>interpret the parameters of the model in context.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Use a line of best fit to make a prediction.</td>
<td></td>
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<tr>
<td></td>
<td>• Determine if a given linear function is a reasonable model for a set of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>data arising from a real-world situation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Analyzing Residuals</strong></td>
<td>• Compute the residuals for a set of data and a line of best fit.</td>
<td>A1:S-ID.B.6.b</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Determine the residual plot for a given scatterplot and line of best</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>fit.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>• Analyze the residual plot to determine whether the function is an</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>appropriate fit for a linear model.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Strength of Correlation</strong></td>
<td>• Calculate the correlation coefficient for a linear model using</td>
<td>A1:S-ID.C.8&lt;br&gt; A1:S-ID.C.9</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>technology.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Interpret the strength of a linear model based on the correlation</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>coefficient.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Analyze data to draw conclusions about correlation and causation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>set using technology.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Identify limitations of models in real-world contexts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Use a linear, quadratic, or exponential regression model to make a</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>prediction.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>• Interpret the graph of a regression model in the context of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>problem.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lesson | Objectives | Standards | Number of Days
--- | --- | --- | ---
Performance Task: Super Survey Simulator | | A1:F-IF.B.6 | 2
| | A1:S-ID.C.8 | |
| | A1:S-ID.C.9 | |
| | A1:S-ID.B.6.a | |
| | A1:S-ID.B.6.b | |
| | A1:S-ID.B.6.c | |
Unit Test | | | 1

**Discussion Questions & Answers**

1. How are correlation and causation related?
   a. *Correlation indicates that two quantities tend to occur together and there is an association. Causation indicates that one quantity occurs because of another quantity. These are not the same—correlation does not necessarily imply causation.*

2. How do residuals determine the fit of a data model?
   a. *Residuals indicate the distance between the data points and the line of best fit used to model the data set. When there is a pattern in the plot of the residual values, the linear regression is not a good fit.*

3. When is a function a good fit for linear and exponential data?
   a. *A function is a good fit for linear and exponential data when the shape of the data set fits the particular function and when the correlation coefficient is close to 1 or –1.*

**Common Misconceptions**

- Correlation vs. causation
  - Students automatically assume causation when two quantities show a strong correlation.
Classroom Challenge

<table>
<thead>
<tr>
<th>Age (Months)</th>
<th>Height (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>26.1</td>
</tr>
<tr>
<td>6.2</td>
<td>25.3</td>
</tr>
<tr>
<td>7</td>
<td>25.4</td>
</tr>
<tr>
<td>7.3</td>
<td>26.7</td>
</tr>
<tr>
<td>7.4</td>
<td>26</td>
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<td>8.2</td>
<td>27.5</td>
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<td>9.1</td>
<td>28.9</td>
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<td>9.5</td>
<td>23.1</td>
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<td>9.6</td>
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<td>9.8</td>
<td>29.4</td>
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<td>10</td>
<td>29.8</td>
</tr>
<tr>
<td>10.6</td>
<td>30.1</td>
</tr>
<tr>
<td>11</td>
<td>30.2</td>
</tr>
<tr>
<td>11.8</td>
<td>32</td>
</tr>
<tr>
<td>12.2</td>
<td>31.5</td>
</tr>
</tbody>
</table>

Plot the data in a scatterplot and describe the shape. Perform a regression analysis and find the equation of the function that best fits the data. What is the correlation coefficient? What does this value say about the regression?

Are there any possible outliers to the data? Remove any possible outliers, perform another regression, and determine the function that best fits the data. What is the new correlation coefficient? What does this value say about the new regression?

Possible solution pathway:
The data appears to be linear and a line of best fit is \( f(x) = 0.66x + 22.8 \). The correlation coefficient for this regression line is \( r = 0.419 \). This correlation coefficient reflects a poor fit to the data, even though most of the data appears to have a positive correlation. There appears to be two outliers \((7, 35.4)\) and \((9.5, 23.1)\). If we remove these two points, we have the following scatterplot and line of best fit.

Teacher notes:

Remind students they have a regression calculator built into their course.

**Tips on Effective Discussions**

Edgenuity courseware supports students in using mathematical language precisely (MP6), and constructing viable arguments to justify their reasoning (MP3) by including discussion questions for students to complete in a classroom or virtual discussion room setting.

- Make expectations clear. How many times should students post in discussions? Are they required to respond to all questions or just one in each unit? You may also wish to require that students respond to at least one other student’s post in addition to answering the original question themselves.
- Share appropriate rules for online discussions with students. Remind them that online discussions do not convey tone as well as face-to-face discussions, and they should be careful to write things that cannot be misinterpreted (e.g., avoid sarcasm). Likewise, let students know
that they should never post anything in a discussion forum that they would not say in a face-to-face discussion.

- Encourage students to ask follow-up questions in the forum. Discuss with students what makes an effective follow-up question. For example, questions should elicit elaboration, as opposed to having a single correct answer.

- Let students know that there is no shame in changing one’s views in response to new information posted by others. In fact, that is part of what discussions are all about.

- If you facilitate online discussions, post discussion questions at the start of the unit so students can return to them multiple times. Students are often motivated to contribute more when they see the contributions of other students over time. Once you have posted questions, send students an email to let them know that forums are open.

- If you facilitate face-to-face discussions, make clear to students what they should come prepared to discuss. You may wish to provide the discussion questions in advance of the discussion. When discussions happen in real time, this allows less confident students to feel more prepared and have evidence to support their ideas.
# Course Vocabulary List

All of the words below are taught to students in the course of instruction. Students have access to definitions in their lesson glossaries and can look up any word at any time within instruction and assignments.

<table>
<thead>
<tr>
<th>absolute value</th>
<th>function</th>
<th>quadratic function</th>
</tr>
</thead>
<tbody>
<tr>
<td>absolute value function</td>
<td>function notation</td>
<td>qualitative data</td>
</tr>
<tr>
<td>acceleration</td>
<td>geometric sequence</td>
<td>quantitative data</td>
</tr>
<tr>
<td>accuracy</td>
<td>greatest common factor</td>
<td>quantity</td>
</tr>
<tr>
<td>additive inverse</td>
<td>histogram</td>
<td>radical</td>
</tr>
<tr>
<td>affect</td>
<td>horizontal asymptote</td>
<td>random sample</td>
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<td>rate</td>
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<td>arithmetic sequence</td>
<td>identity property of addition</td>
<td>rate of change</td>
</tr>
<tr>
<td>association</td>
<td>identity property of multiplication</td>
<td>rational number</td>
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<td>assume</td>
<td>independent variable</td>
<td>reciprocal</td>
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<td>axis of symmetry</td>
<td>index</td>
<td>recursive formula</td>
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<tr>
<td>base</td>
<td>inequality</td>
<td>reflection</td>
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<tr>
<td>biased sample</td>
<td>initial value</td>
<td>regression</td>
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<td>binomial</td>
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<td>relation</td>
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<td>boundary line</td>
<td>interpolation</td>
<td>relative frequency</td>
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<td>causation</td>
<td>interpret</td>
<td>represent</td>
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<tr>
<td>ceiling function</td>
<td>interval</td>
<td>residual</td>
</tr>
<tr>
<td>coefficient</td>
<td>inverse operation</td>
<td>residual plot</td>
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<td>common difference</td>
<td>irrational number</td>
<td>root</td>
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<td>common ratio</td>
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<td>sample skewed</td>
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<td>compare</td>
<td>joint frequency</td>
<td>scatterplot</td>
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<td>---------</td>
<td>-----------------</td>
<td>-------------</td>
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<td>compound inequality</td>
<td>leading coefficient</td>
<td>scenario</td>
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<td>construct</td>
<td>marginal frequency</td>
<td>slope-intercept form</td>
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<td>continuous graph</td>
<td>maximum</td>
<td>solution</td>
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<tr>
<td>convert</td>
<td>mean</td>
<td>solution set</td>
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<tr>
<td>coordinate plane</td>
<td>measure of center</td>
<td>solution to a system of equations</td>
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<tr>
<td>correlation</td>
<td>measure of variability</td>
<td>square root property of equality</td>
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<td>correlation coefficient</td>
<td>measurement</td>
<td>standard deviation</td>
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<tr>
<td>cube root</td>
<td>median</td>
<td>standard form of a linear equation</td>
</tr>
<tr>
<td>degree of a polynomial</td>
<td>midpoint</td>
<td>step function</td>
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<td>dependent variable</td>
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<td>strategy</td>
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<td>monomial</td>
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<td>negative slope</td>
<td>substitute</td>
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<td>normal distribution</td>
<td>system of inequalities</td>
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<td>number line</td>
<td>system of linear equations</td>
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<td>term</td>
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<td>outlier</td>
<td>translation</td>
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<td>dot plot</td>
<td>output</td>
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<tr>
<td>eliminate</td>
<td>parabola</td>
<td></td>
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</tbody>
</table>
Students use a variety of powerful interactive instructional tools to help them build content knowledge and essential skills, support them in learning procedures, and facilitate the exploration of new or challenging concepts throughout Edgenuity Algebra I.

**Unit 1**

**Quantitative Reasoning**

- An interactive allows students to analyze the relationship between distance and time by walking a turtle.
Dimensional Analysis
- An interactive supports students through converting units of rates step-by-step.

Expressions in One Variable
- An interactive allows students to substitute a value for a variable and evaluate the expression step-by-step.

UNIT 2

Slope of a Line
- An interactive supports students in calculating the slope of a line that passes through two specific points.

Slope-Intercept Form of a Line
- An interactive graph assists students in graphing a linear function in slope-intercept form step-by-step.
- An interactive graph allows students to graph a linear function in slope-intercept form to determine a point that lies on the line.
- An interactive graph allows students to investigate the y-intercept by changing the y-intercept with a slider.
- An interactive graph allows students to investigate the slope by changing the slope with a slider.

Point-Slope Form of a Line
- An interactive graph allows students to graph a linear function in point-slope form step-by-step.
- An interactive graph allows students to graph a linear function in point-slope form to determine the y-intercept.

Standard Form of a Line
- An interactive graph allows students to graph a linear function in standard form step-by-step.
- An interactive graph allows students to graph a linear function in standard form to determine a point on the line.

Writing Linear Equations
- An interactive allows students to write the equation of a line passing through two points step-by-step.

Absolute Value Functions and Translations
- An interactive graph allows students to explore translations of the parent absolute value function by moving a slider to change the value of $k$ in $f(x) = |x| + k$. 
• An interactive graph allows students to graph a translated absolute value function of the form 
  \( f(x) = |x| + k \) step-by-step.
• An interactive graph allows students to explore translations of the parent absolute value 
  function by moving a slider to change the value of \( h \) in \( g(x) = |x - h| \).
• An interactive graph allows students to graph a translated absolute value function of the form 
  \( f(x) = |x - h| + k \) step-by-step.

Reflections and Dilations of Absolute Value Functions

• An interactive graph allows students to explore dilations of an absolute value function of the 
  form \( f(x) = a|x| \) by moving a slider to change the value of \( a \).
• An interactive graph allows students to graph a dilation of the parent absolute value function 
  step-by-step.
• An interactive graph allows students to graph a dilated and translated absolute value function 
  step-by-step.

UNIT 3

Equations in One Variable

• An interactive equation solver supports a student in solving a word problem using a two-step 
  equation step-by-step.
• An interactive equation solver allows a student to apply properties to an equation to solve a 
  problem.
• An interactive number line allows a student to plot the solution set of a one-variable equation.

Solving Linear Equations: Variable on One Side

• An interactive equation solver supports students as they solve a linear equation step-by-step.
• An interactive equation solver allows students to apply properties to solve a linear equation.

Solving Linear Equations: Variables on Both Sides

• An interactive equation solver supports students as they solve a linear equation step-by-step.
• An interactive equation solver allows a student to apply properties to solve a linear equation.

Solving Linear Equations: Distributive Property

• An interactive equation solver supports students as they solve a linear equation step-by-step.
• An interactive equation solver allows students to apply properties to solve a linear equation.

Literal Equations

• An interactive equation solver supports students in solving a literal equation step-by-step.

Inequalities in One Variable
• An interactive equation solver supports students in applying properties of inequality to solve a two-step inequality.
• An interactive equation solver supports students in applying properties of inequality to solve a two-step inequality, answering in interval notation.
• An interactive number line allows students to graph the solution of a two-step inequality.

**Solving One-Variable Inequalities**

• An equation solver supports students in solving a multistep inequality step-by-step.
• An equation solver supports students in graphing the solution to a multistep inequality.
• An equation solver supports students in graphing the solution to a multistep inequality, answering in interval notation.

**Solving Mixture Problems**

• Interactive tables allow students to organize information for mixture problems.

**Solving Rate Problems**

• Interactive tables allow students to organize information for rate problems.

**UNIT 4**

**Introduction to Systems of Linear Equations**

• An interactive graph allows students to graph a system of linear equations to determine its solution.

**Solving Systems of Linear Equations: Graphing**

• An interactive graph allows students to graph a system of linear equations to determine its solution(s) step-by-step.
• An interactive graph allows students to analyze a system of equations with no solution by changing the slope and y-intercept of one equation with a slider.

**Solving Systems of Linear Equations: Substitution**

• An equation solver assists students in solving a system of linear equations using substitution.

**Solving Systems of Linear Equations: Linear Combinations**

• An equation solver supports students in solving a system of linear equations via linear combination step-by-step.

**UNIT 5**

**Introduction to Compound Inequalities**
• An interactive number line allows students to graph a compound inequality to help answer a question about it.
• An interactive number line allows students to graph the solution to a compound inequality to determine possible values in the solution set.

Solving Compound Inequalities
• An equation solver supports students in solving an “and” compound inequality step-by-step.
• An equation solver supports students in solving an “or” compound inequality step-by-step.
• An interactive number line allows students to graph the solution set of an “or” compound inequality.

Graphing Two-Variable Linear Inequalities
• An interactive graph allows students to graph a linear inequality step-by-step, beginning with the slope and y-intercept.
• An interactive graph allows students to graph a linear inequality using the x- and y-intercepts of the boundary line.

Modeling with Two-Variable Linear Inequalities
• An interactive graph supports students in graphing a real-world linear inequality using the x- and y-intercepts of the boundary line.

UNIT 6

Exponential Growth Functions
• An interactive graph allows students to graph an exponential growth function.

Exponential Decay Functions
• An interactive graph allows students to graph an exponential decay function.

Vertical Stretches and Shrinks of Exponential Functions
• An interactive graph allows students to explore initial values of exponential functions that are not equal by moving a slider to change the initial value.
• An interactive graph allows students to graph an exponential function with an initial value greater than 1 step-by-step.

Reflections of Exponential Functions
• An interactive graph allows students to graph an exponential function reflected over the x-axis step-by-step.
• An interactive graph allows students to graph an exponential function reflected over the y-axis step-by-step.

Translations of Exponential Functions

• An interactive graph allows students to graph a horizontal translation of an exponential function step-by-step.
• An interactive graph allows students to graph a vertical translation of an exponential function step-by-step.

Exponential Functions with Radical Bases

• An interactive allows students to break a composite number into prime factors to determine key aspects of exponential functions with rational exponents.

UNIT 7

Introduction to Polynomials

• Algebra tiles allow students to represent polynomials by building one term at a time.

Multiplying Monomials and Binomials

• Algebra tiles allow students to multiply a monomial by a binomial step-by-step.
• Algebra tiles allow students to multiply two binomials.
• An interactive table allows students to multiply two binomials.

Multiplying Polynomials and Simplifying Expressions

• An interactive table allows students to multiply a binomial by a trinomial.

Factoring Polynomials: Double Grouping

• An interactive equation solver allows students to factor a third-degree polynomial by grouping step-by-step.
• An equation solver allows students to factor a quadratic polynomial by grouping without combining like terms step-by-step.

UNIT 8

Factoring Trinomials: $a = 1$

• Algebra tiles allow students to factor trinomials with leading coefficients equal to 1.

Factoring Trinomials: $a = 1$ (Continued)

• Algebra tiles allow students to factor a trinomial with a leading coefficient of 1.
Factoring Trinomials: \( a > 1 \)
- Algebra tiles allow students to factor trinomials with leading coefficients greater than 1.

Factoring Polynomials: Difference of Squares
- Algebra tiles allow students to factor a difference of perfect squares.

UNIT 9

Quadratic Functions: Standard Form
- An interactive graph allows students to graph a quadratic function given in standard form.

Quadratic Functions: Factored Form
- An interactive graph allows students to graph a quadratic function given in factored form.
- An interactive graph allows students to locate the \( x \)-intercept of a double root quadratic function given in factored form.
- An interactive graph allows students to graph a double root quadratic function.

Quadratic Functions: Vertex Form
- An interactive graph allows students to graph a quadratic function given in vertex form.
- An interactive graph allows students to explore translations of quadratic functions of the form \( g(x) = x^2 + k \) by moving a slider to change the value of \( k \).
- An interactive graph allows students to explore translations of quadratic functions of the form \( g(x) = (x - h)^2 \) by moving a slider to change the value of \( h \).

Completing the Square
- Algebra tiles allow students to write a quadratic function in vertex form by completing the square.

UNIT 10

Step Functions
- An interactive graph allows students to graph a step function.

Linear Growth vs. Exponential Growth
- Students play a game in which they feed a frog to compare linear and exponential growth.

UNIT 11

Quadratic Equations and Their Related Functions
• Interactive graphs allow students to solve quadratic equations by graphing their related functions.

Solving Quadratic Equations: Zero Product Property
• An interactive equation solver allows students to solve a quadratic equation by factoring step-by-step.

Solving Quadratic Equations: Completing the Square (Continued)
• An equation solver allows students to solve a quadratic equation with leading coefficient greater than 1 by completing the square step-by-step.

UNIT 12

Two-Way Tables
• An interactive table allows students to create a two-way frequency table to represent a real-world scenario.
• An interactive table allows students to create a two-way relative frequency table to represent a real-world scenario.

Relative Frequencies and Association
• An interactive table allows students to create a conditional relative frequency table by row to represent a real-world scenario.

Measures of Center
• An interactive allows students to create a dot plot for a set of data.
• An interactive allows students to create a dot plot for a set of data to determine the best measure of center to describe it.
• An interactive graph allows students to create a histogram for a set of data step-by-step.

UNIT 13

Introduction to Modeling with Functions
• An interactive graph allows students to plot data and determine an equation to model it.

Strength of Correlation
• An interactive allows students to order correlation coefficients from weakest to strongest.

Regression Models
• An interactive graph allows students to plot data and determine the type of function that would best model it.

Performance Task: Super Survey Simulator
• An interactive data-collecting simulation allows students to conduct a survey.

COURSE CUSTOMIZATION
Edgenuity is pleased to provide an extensive course customization toolset, which allows permissioned educators and district administrators to create truly customized courses that ensure our courses can meet the demands of the most rigorous classroom or provide targeted assistance for struggling students.

Edgenuity allows teachers to add additional content two ways:

1. Create a brand-new course: Using an existing course as a template, you can remove content; add lessons from the Edgenuity lesson library; create your own activities; and reorder units, lessons, and activities.

2. Customize a course for an individual student: Change an individual enrollment to remove content; add lessons; add individualized activities; and reorder units, lessons, and activities.

Below you will find a quick start guide for adding lessons in from a different course or from our lesson library.
In addition to adding lessons from another course or from our lesson library, Edgenuity teachers can insert their own custom writing prompts, activities, and projects.
If you previously created new activities, they will display here. Click the activity name to preview the activity instructions.

Click the green plus sign to insert an activity into the lesson.

The activity will be inserted at the top of the unit. You can move the activity to another location in the lesson.

If you are creating a new Writing Prompt, specify the name, description, prompt, grade weight category, and optionally, keywords for scoring, sample answer, and scoring guidance.

If you are creating a new Project, specify the name, description, type, and grade weight category, and provide student resources by entering hyperlinks to websites or uploading files.

NOTES

- Accepted file types are: .ppt, .pptx, .xls, .xlsx, .doc, .docx, .zip, .pdf, .accdb, .msg.

- Links you create won’t go through the Edgenuity Emissary (Proxy). This means that your IT department will need to ensure that the link is whitelisted or otherwise allowed to be accessed. It also means that items blocked by the Edgenuity proxy may be visible on the sites you link to. In addition, the Edgenuity tools to highlight, translate, read aloud, or add a sticky note will not be present on the sites you link to.

- You add activities to courses with no enrollments or on individual student’s courses. It is not possible to add activities to in-flight courses that have enrollments.