Algebra 1

Full year, one credit, 5 periods per week, first High School Mathematics Course

The Mathematics Curriculum for high school students in the Lakewood City Schools is based on the Common Core State Standards as adopted by the Ohio State Board of Education.

Lakewood has chosen to do a traditional course sequence (Algebra I, Geometry, Algebra II). There are six major areas of focus throughout the four years of high school mathematics required by the state of Ohio, including Algebra 2 for all students. The six focus areas are: Modeling, Number & Quantity, Algebra, Functions, Geometry, Statistics & Probability. These six areas of focus are split between Algebra 1, Geometry and Algebra II to be covered. Additionally, there is a focus on the transition from high school to post-secondary education for college and careers.

Algebra 1 will have the following major focus areas and their sub-focuses (Domains):

- Modeling
  - Imbedded within units
- Number & Quantity (N)
  - Quantities (Q)
  - Complex Numbers (CN)
- Algebra (A)
  - Seeing Structure in Expressions (SSE)
  - Reasoning with Equations and Inequalities (REI)
  - Creating Equations (CED)
- Functions (F)
  - Interpreting Functions (IF)
  - Building Functions (BF)
  - Linear, Quadratic and Exponential Models (LE)
- Statistics & Probability (S)
  - Interpreting Categorical Quantitative Data (ID)

The Standards for Mathematical Practice describes varieties of expertise that mathematics educators at all levels should seek to develop in their students. These Standards appear at EVERY grade level. These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education. The first of these are the NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections. The second are the strands of mathematical proficiency specified in the National Research Council's report *Adding It Up:* adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibility, accurately, efficiently and appropriately), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy).

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

1. Make sense of problems and persevere in solving them.

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

High School students start to examine problems by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. By high school, students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. They check their answers to problems using different methods and continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

2. Reason abstractly and quantitatively.

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantities relationships: the ability to *decontextualize* – to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents – and the ability to *contextualize,* to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

High school students seek to make sense of quantities and their relationships in problem situations. They abstract a given solution and represent it symbolically, manipulate the representing symbols, and pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Students use quantitative reasoning to create coherent representations of the problem at hand; consider the units involved; attend to the meaning of quantities, not just how to compute them; and know and flexibly use different properties of operations and objects.

3. Construct viable arguments and critique the reasoning of others.

Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and – if there is a flaw in argument – explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to

determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

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4. Model with mathematics.

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

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5. Use appropriate tools strategically.

Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebraic system, a statistical package, or dynamic geometric software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

High School students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebraic system, a statistical package, or dynamic geometric software. High school students should be sufficiently familiar with tools appropriately for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. They are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technology tools to explore and deepen their understanding of concepts.

6. Attend to precision.

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem, They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

High School students try to communicate precisely to others by using clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

7. Look for and make use of structure.

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7×8 equals the well remembered $7 \times 5 + 7 \times 3$, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14,$ older students can see the 14 as 2×7 and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift prospective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and $y.$

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8. Look for and express regularity in repeated reasoning.

Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through $(1, 2)$ with slope 3, middle school students might abstract the equation $(y - 2) / (\mathrm{x} - 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x - 1)(x + 1),$ $(x - 1)(x^2 + \mathrm{x} + 1),$ and

$(x-1)(x^3+x^2+x+1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.

High School students notice if calculations are repeated, and look both for general methods and for shortcuts. Noticing the regularity in the way terms cancel when expanding $(x-1)(x+1)$, $(x-1)(x^2+x+1)$, *and* $(x-1)(x^3+x^2+x+1)$ *might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, derive formulas or make generalizations, high school students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.*

Modeling with Functions
N.Q.1; N.Q.2; N.Q.3; F.IF.1; F.IF.2; F.IF.3; F.IF.4; F.IF.5; F.IF.8, F.IF.9; F.LE.1; F.LE.3; F.LE.5

Enduring Understandings:

- Interpreting numbers as quantities with appropriate units, scales, and levels of accuracy allows one to effectively model and make sense of real world problems.
- Equations, verbal descriptions, graphs, and tables provide insight into the relationship between quantities.
- Lines, exponential functions, and parabolas each describe a specific pattern of change.

Essential Questions:

- In what ways can the choice of units, quantities, and levels of accuracy impact a solution?
- How can the relationship between quantities best be represented?
- When does a function best model a situation?

Clusters:

- Reason quantitatively and use units to solve problems.
- Understand the concept of function and use function notation.
- Interpret function that arise in applications in terms of the context.
- Analyze functions using different representations.
- Construct and compare linear, quadratic, and exponential models and solve problems.

- Interpret expressions for functions in terms of the situation they model.

Standard	Clear Learning Targets	Mathematical Practices	Vocabulary
N.Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.	I can label units through multiple steps of a problem. I can choose appropriate units for real world problems involving formulas. I can use and interpret units when solving formulas. I can choose an appropriate scale and origin for graphs and data displays. I can interpret the scale and origin for graphs and data displays.	1. Make sense of problems and persevere in solving them. **2. <u>Reason abstractly and quantitatively.</u>** **3. <u>Construct viable arguments and critique the reasoning of others.</u>** 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Scale
N.Q.2 Define appropriate quantities for the purpose of descriptive modeling. ⋆ ⋆Modeling	I can identify the variables or quantities of significance from the data provided. I can identify or choose the appropriate unit of measure for each variable or quantity.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>** 5. Use appropriate tools strategically.	Descriptive model

		6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	
N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities	I can report measured quantities in a way that is reasonable for the tool used to make the measurement (e.g., 5.1 cm is a reasonable way to report a length measured on a typical ruler, but 5.1476 cm is not. If time is measured on a stopwatch, 1:23:45.78 is a reasonable way to report a time; it is not appropriate if time is measured on a wall clock). I can report calculated quantities using the same level of accuracy as used in the problem statement.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. **5. <u>Use appropriate tools strategically.</u>** **6. <u>Attend to precision.</u>** 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Accuracy
F.IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its	I can define relation, domain, and range. I can define a function as a relation in which each input (domain) has exactly one output (range).	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively.	Domain Range Function Relation

domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.	I can determine if a graph, table, or set of ordered pairs that represent a function. *For example:* ● *Student's name and student's date of birth will represent a function since every input was only born once;* ● *A date and a famous person born on that date may not represent a function since a date could be matched to more than one person;* ● *A number and twice the input will represent a function since every number has only one double;* ● *A number and a number less than two units from the input will not represent a function since there are many outputs that match each input.* I can explain that when x is an element of the input of a function, $f(x)$ represents that corresponding output of the function.	3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. **6. <u>Attend to precision.</u>** **7. <u>Look for and make use of structure.</u>** 8. Look for and express regularity in repeated reasoning.	Input Output Element Function notation

	I can explain that function notation is not limited to $f(x)$; other letters (e.g., $g(x)$ and $p(x)$) can also be used so we can tell different functions apart. I can explain that the graph of f is the graph of the equation $y = f(x)$.		
F.IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.	I can decode function notation and explain how the output of a function is matched to its input (e.g., The function $f(x) = 2x^2 + 4$ squares the input, doubles the square, and adds four to produce the output.). I can convert a table, graph, set of ordered pairs, or description into function notation by identifying the rule used to turn inputs into outputs and writing the rule. I can use order of operations to evaluate a function for a given domain (input) value. I can identify the numbers that are not in the domain of a function (e.g., 0 is not in the domain of $g(x) = 1/x$	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. Look for and express regularity in repeated reasoning.	Function Function notation Domain Range Order of operations Input Output

	and negative numbers are not in the domain of $h(x) = \sqrt{x}$). I can choose inputs that make sense based on a problem situation. I can analyze the input and output values of a function based on a problem situation.		
F.IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. *For example, the Fibonacci sequence is defined recursively by* $f(0) = f(1) = 1, \quad f(n+1) = f(n) + f(n-1)$ *for* $n \geq 1$.	I can convert a list of numbers (a sequence) into a function by making the whole numbers (0, 1, 2, etc.) the inputs and the elements of the sequence the outputs. I can explain that recursive formula tells me how a sequence starts and tells me how to use the previous value(s) to generate the next element of the sequence. I can explain that an explicit formula allows me to find any element of a sequence without knowing the element before it (e.g., If I want to know the 11th number on the list, I plug the number 11 into the explicit formula.). I can distinguish between explicit and recursive formulas for sequences.	1. Make sense of problems and persevere in solving them. **2. <u>Reason abstractly and quantitatively.</u>** 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** **8. <u>Look for and express regularity in repeated reasoning.</u>**	Function Domain Range Integers Sequence Explicit formula Recursive formula

F.IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. ⋆ a. Focus on linear quadratic and exponential functions (A1, M2) *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.* ⋆ Modeling	I can locate the information that explains what each quantity represents. I can interpret the meaning of an ordered pair (e.g., the ordered pair (9, 90) could mean that a person earned $90 after working 9 hours.). I can determine if negative inputs make sense in the problem situation. I can determine if negative outputs make sense in the problem situation. I can identify the y-intercept. I can use the definition of function to explain why there can only be one y-intercept. I can use the definition of function to explain why there can only be one y-intercept. I can use the problem situation to explain what the y-intercept means. I can identify the x-intercept(s). I can use the definition of function to explain why some functions have more than one x-intercept.	**1. Make sense of problems and persevere in solving them.** 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. **7. Look for and make use of structure.** **8. Look for and express regularity in repeated reasoning.**	Interval Maximum Minimum Symmetry End behavior Periodicity

	I can use the problem situation to explain what an x-intercept means. I can define “increasing interval” as a set of function inputs for which the output increases as the input increases. I can define “decreasing interval” as a set of function inputs for which the output decreases as the input increases. I can use the problem situation to explain the end behavior of a function. I can locate the information that explains what each quantity represents. I can decide which quantity should be used as the input. I can identify which parts of the description indicate, if applicable, the functions y-intercept, x-intercept(s), increasing intervals, decreasing intervals, relative minimums, relative maximums, symmetries and end behaviors,		

	I can create a graph that matches the description that indicates all of the key features of the function.		
F.IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. ⋆ a. Focus on linear, quadratic, and exponential functions (A1, M2) *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.* ⋆ Modeling	I can explain how the domain of a function is represented in its graph. I can state the appropriate domain of a function that represents a problem situation, defend my choice, and explain why other numbers might be excluded from the domain.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>** 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Function Domain
F.IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. b.Use the properties of exponents to interpret expressions for exponential functions. (A1, M3)	I can use function notation. I can write a function that models an exponential situation I can evaluate an exponential function for integer inputs	1. Make sense of problems and persevere in solving them. **2. <u>Reason abstractly and quantitatively.</u>** 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically.	

i. Focus on exponential functions evaluated at integer inputs. (A1, M2)		6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. Look for and express regularity in repeated reasoning.	
F.IF.9 Compare properties of two functions each represented in a different way (algebraic, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.* b. Focus on linear, quadratic, and exponential functions (A1, M2)	I can compare properties of two functions when represented in different ways (algebraically, graphically, numerically in tables, or by verbal descriptions).	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. Look for and express regularity in repeated reasoning.	Evaluate Function Coordinate plane Algebraically Numerically Verbally
F.LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions. a. Show that linear functions grow by equal differences over equal intervals, and that	I can define linear function $(y = mx + b)$ and exponential function $y = ab^x$.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively.	Linear function Exponential function Evaluate Rate of change

exponential functions grow by equal factors over equal intervals. b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another	I can demonstrate that a linear function has a constant rate of change (slope). I can demonstrate that an exponential function has a constant multiplier (common ratio) over equal intervals. I can identify situations that display equal rates of change over equal intervals and can be modeled with linear functions. I can identify exponential growth and decay by the growth rate I can distinguish between situations modeled with linear functions and with exponential functions when presented with a real-world problem.	**3. Construct viable arguments and critique the reasoning of others.** **4. Model with mathematics.** 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. **8. Look for and express regularity in repeated reasoning.**	Slope Common ratio
F.LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).★	I can study properties of exponential functions. I can write an exponential function. I can analyze data and real world situations to find a function to use.		
F.LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically. (A1, M2).	I can use graphs or tables to compare the output values of linear, quadratic, polynomial, and exponential functions.	1. Make sense of problems and persevere in solving them. **2. Reason abstractly and quantitatively.**	Evaluate Function Linear function

	I can estimate the intervals for which the outputs of one function is greater than the output of another function when given a table or graph. I can use technology to find the point at which the graphs of two functions intersect. I can use the points of intersection to precisely list the intervals for which the output of one function is greater than the output of another function. I can use graphs or tables to compare the rates of change of linear, quadratic, polynomial, and exponential functions. I can explain why exponential functions eventually have greater output values than linear, quadratic, or polynomial functions by comparing simple functions of each type.	3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. **8. <u>Look for and express regularity in repeated reasoning.</u>**	Quadratic function Polynomial function Exponential function Rate
F.LE.5 Interpret the parameters in a linear or exponential function in terms of a context.	I can identify the names and definitions of the parameters m and b in the linear function $f(x) = mx + b.$ I can explain the meaning (using appropriate units) of the slope of a	1. Make sense of problems and persevere in solving them. **2. <u>Reason abstractly and quantitatively.</u>** 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>**	Linear function Exponential function Domain Range Slope

	line when the line models a real-world relationship. I can explain the meaning (using appropriate units) of the y-intercept and other points on the line when the line models a real-world relationship. I can compose an original problem situation and construct a linear function to model it. I can identify the names and definitions of the parameters a, b and c in the exponential function $f(x) = a \cdot b^x + c$. I can explain the meaning (using appropriate units) of the constant a of an exponential function when the exponential function models a real-world relationship. I can explain the meaning (using appropriate units) of the y-intercept and other points on an exponential function when the exponential function models a real-world relationship.	5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	y-intercept Asymptote Growth rate

	I can explain the meaning (using appropriate units) of the constant b of an exponential function when the exponential function models a real-world relationship. I can explain the meaning (using appropriate units) of the constant c of an exponential function when the exponential function models a real-world relationship. I can compose an original problem situation and construct an exponential function to model it.		

Linear Functions
F.IF.6; F.IF.7; F.IF.9; F.BF.1; F.BF.2; F.LE.1

Enduring Understanding:

- Equations, verbal descriptions, graphs, and tables provide insight into the relationship between quantities.
- Functions can be created by identifying the pattern of a relationship or by applying geometric transformations to an existing function.
- Lines, exponential functions, and parabolas each describe a specific pattern.

Essential Questions:

- How can the relationship between quantities best be represented?
- In what ways can functions be built?
- When does a function best model a situation?

Clusters:

- Interpret functions that arise in applications in terms of the context.
- Analyze functions using different representations.
- Build a function that models a relationship between two quantities.
- Build new functions from existing functions.
- Construct and compare linear, quadratic, and exponential models to solve problems.

Standard	Clear Learning Targets	Mathematical Practices	Vocabulary
F.IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. ⋆ ⋆ Modeling	I can define interval, rate of change, and average rate of change. I can explain the connection between average rate of change and the slope formula: $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\Delta y}{\Delta x}$.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>**	Function Notation Linear Function Nonlinear Function Rate of change Average rate of change

	I can calculate the average rate of change of a function, represented either by function notation, a graph, or a table, over a specific input interval. I can compare the rates of change of two or more functions when they are represented with function notation, with a graph, or with a table. I can interpret the meaning of the average rate of change (using units) as it relates to a real-world problem.	**5. <u>Use appropriate tools strategically.</u>** 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Interval
F.IF.7 Graph functions expressed symbolically and indicate key features of the graph, by hand in simple cases and using technology for more complicated cases. Include applications and how key features relate to characteristics of a situation, making selection of a particular function and model appropriate. ⋆ a. Graph linear functions and indicate intercepts. b. Graph simple exponential functions, including intercepts and end behavior. ⋆ Modeling	I can decide which functions are relatively easy to sketch by hand and which functions should be graphed using technology. I can identify the x-intercept(s), y-intercept, increasing interval, decreasing intervals, the maximums, and minimums of a function by looking at its graph. I can identify that the parent function for lines is the line $f(x) = x.$ I can identify the point-slope form of a linear function as $y - y_1 = m(x - x_1).$	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. **<u>Look for and express regularity in repeated reasoning.</u>**	Evaluate Function Domain Input Equation Parent Function Slope-intercept form x-intercept y-intercept Origin

	I can graph a line in point-slope form and use the graph to show where the starting point (x_1, y_1) and the slope (m) are represented on the graph. I can identify the slope-intercept form of a linear function as $f(x) = mx + b.$ I can graph a line in slope-intercept form and use the graph to show where the y-intercept (b) and the slope (m) are represented on the graph. I can identify the standard form of a linear function as $Ax + By = C.$ I can use the definitions of x-intercept and y-intercept to find the intercepts of a standard form line and graph the line. I can relate the constants A, B, and C to the values of the x-intercept, y-intercept, and slope.		Linear function Coordinate plane Maximum Minimum
F.IF.9 Compare properties of two functions each represented in a different way (algebraically,	I can compare properties of two functions when represented in different ways (algebraically,	1. Make sense of problems and persevere in solving them.	Evaluate Function

graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum. (A2, M3)* *b. Focus on linear, quadratic, and exponential functions.*	graphically, numerically in tables, or by verbal descriptions).	2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. Look for and express regularity in repeated reasoning.	Coordinate plane Algebraically Graphically Numerically Verbally
F.BF.1 Write a function that describes a relationship between two quantities.★ a. Determine an explicit expression, a recursive process, or steps for calculation from context. i. Focus on linear and exponential functions. (A1, M1) ii. Focus on situations that exhibit quadratic or	I can define explicit and recursive expressions of a function. I can identify the quantities being compared in a real-world problem. I can write a explicit and/or recursive expressions of a function to describe a real-world problem.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>** 5. Use appropriate tools strategically. 6. Attend to precision. **7. <u>Look for and make use of structure.</u>**	Quantity Function Explicit expression Recursive expression

exponential relationships. (A1, M2) b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model. (A2, M3)		8. Look for and express regularity in repeated reasoning.	
F.BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. ⋆ ⋆ Modeling	I can explain that a recursive formula tells me how a sequence starts and tells me how to use the previous value(s) to generate the next element of the sequence. I can explain that an explicit formula allows me to find any element of a sequence without knowing the element before it. (e.g., if I want to know the 11th number on the list, I plug the number 11 into the explicit formula).	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>** 5. Use appropriate tools strategically. 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. Look for and express regularity in repeated reasoning.	Explicit formula Recursive formula

F.LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions. a. Show that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals. b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.	I can define linear function $(y = mx + b)$ and exponential function $(y = ab^x)$. I can demonstrate that a linear function has a constant rate of change (slope). I can identify situations that display equal rates of change over equal intervals and can be modeled with linear functions. I can distinguish between situations modeled with linear functions and with exponential functions when presented with a real-world problem.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. **3. <u>Construct viable arguments and critique the reasoning of others.</u>** **4. <u>Model with mathematics.</u>** 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. **8. <u>Look for and express regularity in repeated reasoning.</u>**	Linear function Exponential function Evaluate Rate of change Slope

Linear Equations & Inequalities in One Variable
A.REI.1; A.REI.3; A.REI.11; A.CED.1; A.CED.3; A.CED.4

Enduring Understandings:

- There is often an optimal method of manipulating equations and inequalities to solve a mathematical problem; however, other methods, which may not be as efficient, can still provide insight into the problem.
- Relationships between numbers can be represented by equations, inequalities, and systems.

Essential Questions:

- In what ways can the problem be solved, and why should one method be chosen over another?
- How can algebra describe the relationship between sets of numbers?

Clusters:

- Understand solving equations as a process of reasoning and explain the reasoning.
- Solve equations and inequalities in one variable.
- Represent and solve equations and inequalities graphically.
- Create equations that describe numbers of relationships.

Standard	Clear Learning Targets	Mathematical Practices	Vocabulary
A.REI.1 Explain each step in solving a simple question 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.	I can apply order of operations and inverse operations to solve equations. I can construct an argument to justify my solution process.	1. Make sense of problems and persevere in solving them. **2. <u>Reason abstractly and quantitatively.</u>** **3. <u>Construct viable arguments and critique the reasoning of others.</u>** 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision.	

		7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	
A.REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.	I can solve linear equations in one variable including equations with coefficients represented by letters. I can solve linear inequalities in one variable including equations with coefficients represented by letters.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. **5. <u>Use appropriate tools strategically.</u>** 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. Look for and express regularity in repeated reasoning.	Linear equation Linear inequality Coefficient
A.REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x);$ find the solutions	I can explain that a point of intersection on the graph of a system of equations, $y = f(x)$ and $y = g(x),$ represents a solution to both equations.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others.	x-coordinate Intersection Solution Linear function

approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. ⋆ Modeling	I can infer that since $y = f(x)$ and $y = g(x), \quad f(x) = g(x)$ by the substitution property. I can infer that the x-coordinate of the points of intersection for $y = f(x)$ and $y = g(x)$ are also solutions for $f(x) = g(x).$ I can use a graphing calculator to determine the approximate solutions to a system of equations, $f(x)$ and $g(x).$	4. Model with mathematics. **5. <u>Use appropriate tools strategically.</u>** 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Exponential function Substitution property
A.CED.1 Create equations and inequalities in one variable and use them to solve problems. ⋆ *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* ⋆ Modeling a. Focus on applying linear and simple exponential expressions (A1, M1) b. Focus on applying simple quadratic expressions (A1, M2)	I can identify the variables and quantities represented in a real-world problem. I can determine the best model for the real-world problem (linear equation, linear inequality, quadratic equation, quadratic inequality and exponential equation). I can write the equation or inequality that best models the problem. I can solve the equation or inequality.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>** 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure.	Linear Quadratic Exponential

	I can interpret the solution in the context of the problem.	8. Look for and express regularity in repeated reasoning.	
A.CED.3 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.* (A1, M1) ⋆ Modeling	I can identify the variables and quantities represented in a real-world problem. I can determine the best models for the real-world problem (e.g., linear equation, linear inequality, quadratic equation, quadratic inequality). I can write the system of equations and/or inequalities that best models the problems. I can graph the system on coordinate axes with appropriate labels and scales. I can interpret solutions in the context of the situation modeled and decide if they are reasonable.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>** 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Constraints System of equations System of inequalities Linear Quadratic Scale Coordinate axes Labels Solutions
A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. ⋆ a. Focus on formulas in which the variable in which the variable of interest is linear or square	I can solve formulas for a specified variable.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>**	

For example, rearrange Ohm's law $V = IR$ *to highlight resistance* R, *or rearrange the formula for the area of a circle* $A = \pi r2$ *to highlight radius, r* (A1) ⋆ Modeling		5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	

Linear Equations & Inequalities in Two Variables

A.CED.1; A.CED.3; A.CED.4; A.REI.5; A.REI.6; A.REI.10; A.REI.12

Enduring Understandings:

- Relationships between numbers can be represented by equations, inequalities, and systems.
- There is often an optimal method of manipulating equations and inequalities to solve a mathematical problem; however, other methods, which may not be as efficient, can still provide insight into the problem.

Essential Questions:

- How can algebra describe the relationship between sets of numbers?
- In what ways can the problem be solved, and why should one method be chosen over another?

Clusters:

- Create equations that describe numbers or relationships.
- Solve systems of equations.
- Represent and solve equations and inequalities graphically.

Standard	Clear Learning Targets	Mathematical Practices	Vocabulary
A.CED.1 Create equations and inequalities in one variable and use them to solve problems. ⋆ *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* ⋆ Modeling c. Focus on applying linear and simple exponential expressions (A1, M1)	I can identify the variables and quantities represented in a real-world problem. I can determine the best model for the real-world problem (e.g., linear, quadratic). I can write the equation that best models the problem.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>** 5. Use appropriate tools strategically. 6. Attend to precision.	

d. Focus on applying simple quadratic expressions (A1, M2)		7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	
A.CED.3 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.* (A1, M1)	I can identify the variables and quantities represented in a real-world problem. I can determine the best models for the real-world problems. I can write the system of equations and/or inequalities that best models the problems. I can graph the system on coordinate axes with appropriate labels and scales. I can interpret solutions in the context of the situation modeled and decide if they are reasonable.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>** 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Constraints System of equations System of inequalities Linear Scale Coordinate axes Labels Solutions
A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. ⋆ b. Focus on formulas in which the variable in which the variable of interest is linear or square	I can solve formulas for a specified variable.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>**	

For example, rearrange Ohm's law $V = IR$ *to highlight resistance* R, *or rearrange the formula for the area of a circle* $A = \pi r2$ *to highlight radius, r* (A1) ⋆ Modeling		5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	
A.REI.5 Verify that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.	I can define system of equations. I can recall that equivalent equations result when an equation is multiplied by the same number on both sides of the equal sign. I can solve a system of two equations in two variables by elimination. I can demonstrate that replacing one equation with the sum of that equation and a multiple of the other creates a system with the same solutions as the original system.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. **3. <u>Construct viable arguments and critique the reasoning of others.</u>** 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	System of equations Equivalent equations Elimination method
A.REI.6 Solve systems of linear equations algebraically and graphically.	I can define system of linear equations and solution of a system.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively.	System of linear equations Solution of a system Substitution method

a. Limit to pairs of linear equations in two variables (A1, M1)	I can explain why some linear systems have no solutions and identify linear systems that have no solution. I can explain why some linear systems have infinitely many solutions and identify linear systems that have infinitely many solutions. I can solve a system of linear equations algebraically (by elimination or substitution) to find an exact solution. I can graph a linear equation on the coordinate plane. I can determine the approximate solution to a system of linear equations by graphing both equations and estimating the point of intersection.	3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. Look for and express regularity in repeated reasoning.	Elimination method Intersection
A.REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).	I can explain that every point (x, y) on the graph of an equation represents values x and y that make the equation true. I can verify that any point on a graph will result in a true equation with their coordinates are substituted into the equation.	1. Make sense of problems and persevere in solving them. **2. <u>Reason abstractly and quantitatively.</u>** 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically.	

		6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	
A.REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.	I can define linear inequality, half-plane, and boundary. I can graph a linear inequality on a coordinate plane, resulting in a boundary line (solid or dashed) and a shaded half-plane. I can graph a system of linear equations on a coordinate plane. I can graph a system of linear inequalities on a coordinate plane. I can explain that the solution set for a system of linear inequalities is the intersection of the shaded regions (half-planes) of both inequalities. I can check points in the intersection of the half-planes to verify that they represent a solution to the system.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. **5. <u>Use appropriate tools strategically.</u>** 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	System of linear inequalities Solution Half-plane Boundary Intersection Coordinate plane Linear inequality

Quadratic Functions
F.IF.4; F.IF.5; F.IF.7; F.IF.8; F.IF.9; F.BF.3; F.BF.4

Enduring Understanding:

- Equations, verbal descriptions, graphs, and tables provide insight into the relationship between quantities.
- Functions can be created by identifying the pattern of a relationship or by applying geometric transformations to an existing function.

Essential Questions:

- How can the relationship between quantities best be represented?
- In what ways can functions be built?

Clusters:

- Interpret functions that arise in applications in terms of the context.
- Analyze functions using different representations.
- Build a function that models a relationship between two quantities.
- Build new functions from existing functions.

Standard	Clear Learning Targets	Mathematical Practices	Vocabulary
F.IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior. ★(A2, M3)	I can locate the information that explains what each quantity represents. I can interpret the meaning of an ordered pair (e.g., the ordered pair (9, 90) could mean that a person earned $90 after working 9 hours.). I can determine if negative inputs make sense in the problem situation.	**1. <u>Make sense of problems and persevere in solving them.</u>** 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision.	Quadratic Function x-intercept y-intercept Interval Increase Decrease Maximum

b. Focus on linear, quadratic, and exponential functions. (A1, M2)	I can determine if negative outputs make sense in the problem situation. I can identify the y-intercept. I can use the definition of function to explain why there can only be one y-intercept. I can use the definition of function to explain why there can only be one y-intercept. I can use the problem situation to explain what the y-intercept means. I can identify the x-intercept(s). I can use the definition of function to explain why some functions have more than one x-intercept. I can use the problem situation to explain what an x-intercept means. I can define “increasing interval” as a set of function inputs for which the output increases as the input increases. I can define “decreasing interval” as a set of function inputs for which the	**7. Look for and make use of structure.** **8. Look for and express regularity in repeated reasoning.**	Minimum Symmetry End behavior

	output decreases as the input increases. I can use the problem situation to explain the end behavior of a function. I can locate the information that explains what each quantity represents. I can decide which quantity should be used as the input. I can identify which parts of the description indicate, if applicable, the functions y-intercept, x-intercept(s), increasing intervals, decreasing intervals, relative minimums, relative maximums, symmetries, end behaviors, periodicity. I can create a graph that matches the description that indicates all of the key features of the function.		
F.IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers	I can explain how the domain of a function is represented in its graph. I can state the appropriate domain of a function that represents a problem situation, defend my choice, and explain why other numbers might be excluded from the domain.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others.	Function Input Output Domain

would be an appropriate domain for the function. ★ b. Focus on linear, quadratic, and exponential functions. (A1, M2)		**4. <u>Model with mathematics.</u>** 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	
F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. ⋆ a. Graph quadratic functions and indicate intercepts, maxima, and minima. (A1, M2) ⋆ Modeling	I can decide which functions are relatively easy to sketch by hand and which functions should be graphed using technology. I can identify the x-intercept(s), y-intercept, increasing interval, decreasing intervals, the maximums, and minimums of a function by looking at its graph.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. **<u>Look for and express regularity in repeated reasoning.</u>**	Evaluate Function Domain Input Equation Parent function x-intercept y-intercept Coordinate plane
F.IF.8 Write a function defined by an expression in different but equivalent	I can explain that there are three forms of quadratic functions: standard form, vertex form, and factored form.	1. Make sense of problems and persevere in solving them.	Factor Polynomial

forms to reveal and explain different properties of the function. a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.	I can explain that standard form is $f(x) = ax^2 + bx + c.$ I can explain that vertex form is $f(x) = a(x-h)^2 + k$ where the vertex is located at the point $(h,k).$ I can explain that factored form is $f(x) = a(x-x_1)(x-x_2)$ where x_1 and x_2 are x-intercepts of the function. I can explain that the graph of all three forms of quadratic functions is a parabola. I can explain that all parabolas can be written in standard and vertex form, but that parabolas without x-intercepts cannot be expressed in factored form using real numbers. I can find the x-intercepts of a quadratic written in factored form. I can use the x-intercepts of a quadratic to find the axis of symmetry.	**2. <u>Reason abstractly and quantitatively.</u>** 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. Look for and express regularity in repeated reasoning.	Quadratic function Vertex form Complete the square Vertex Extreme value Axis of symmetry Intercept form Zero

	I can use the axis of symmetry of a quadratic to find the vertex of a parabola. I can identify the line of symmetry and the vertex of a parabola. I can identify the line of symmetry and vertex of a quadratic written in vertex form. I can sketch a graph of a parabola written in vertex form. I can tell if a quadratic written in vertex form has x-intercept by looking at the equation. I can use algebra to find the x-intercepts of a quadratic written in vertex form. I can convert a standard form quadratic to factored form by factoring. I can convert a standard form quadratic to vertex form by completing the square. I can demonstrate that the standard, factored, and vertex forms of the same quadratic function produce the		

	same values for the x-intercepts, the y-intercept, and the vertex. I can write the function that describes a parabola in all three forms when I am given a graph with the x-intercepts, y-intercept, and vertex labeled.		
F.IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). (A2, M3) b. Focus on linear, quadratic, and exponential functions. *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*	I can compare properties of two functions when represented in different ways (algebraically, graphically, numerically in tables, or by verbal descriptions).	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. Look for and express regularity in repeated reasoning.	Evaluate Function Coordinate plane Algebraically Graphically Numerically Verbally
F.BF.3 Identify the effect of 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); find the value of k given the graphs. Experiment with cases and illustrate an explanation of	I can explain why $f(x)+k$ translates the original graph of $f(x)$ up k units and why $f(x)-k$ translates	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively.	Function Translate Stretch Shrink

the effects on the graph using technology. a. *Focus on transformations of graphs of quadratic functions, except for f(kx). (A1, M2)*	the original graph of $f(x)$ down k units. I can explain why $f(x+k)$ translates the original graph of $f(x)$ left k units and why $f(x-k)$ translates the original graph of $f(x)$ right k units. I can explain why $kf(x)$ vertically stretches or shrinks the graph of $f(x)$ by a factor of k and predict whether a given value of k will cause a stretch or a shrink. I can explain why $f(kx)$ horizontally stretches or shrinks the graph of $f(x)$ by a factor of $1/k$ and predict whether a given value of k will cause a stretch or a shrink. I can describe the transformation that changed a graph of $f(x)$ into a different graph when given pictures of the pre-image and image.	3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. **5. <u>Use appropriate tools strategically.</u>** 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. Look for and express regularity in repeated reasoning.	

	I can determine the value of k given the graph of a transformed function. I can graph the listed transformations when given a graph of $f(x)$ and a value of k $(f(x)\pm k, f(x\pm k), kf(x),$ and $f(kx))$. I can use a graphing calculator to generate examples of functions with different k values. I can analyze the similarities and differences between functions with different k values.		
F.BF.4 Find inverse functions a. Informally determine the input of a function when output is known. (A1, M1)	I can define inverse of a function. I can write the inverse of a function by solving $f(x)=c$ for x. I can explain that after solving $f(x)=c$ for x, c can be considered the input and x can be considered the output.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision.	Inverse Function Domain

		7. <u>Look for and make use of structure.</u> 8. Look for and express regularity in repeated reasoning.	

Quadratic Equations
A.SSE.3; A.REI.4; A.REI.7

Enduring Understandings:

- Operations and properties of the real number system can be extended to situations involving complex numbers.
- Expressions can be written in multiple ways using the rules of algebra; each version of the expression tells something about the problem it represents.
- There is often an optimal method of manipulating equations and inequalities to solve a mathematical problem; however, other methods, which may not be as efficient, can still provide insight into the problem.

Essential Questions:

- How does knowledge of real numbers help when working with complex numbers?
- Why structure expressions in different ways?
- In what ways can the problem be solved, and why should one method be chosen over another?

Clusters:

- Write expressions in equivalent forms to solve problems.
- Solve equations and inequalities in one variable.
- Solve systems of equations.

Standard	Clear Learning Targets	Mathematical Practices	Vocabulary
A.SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.★ a. Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.	I can factor a quadratic expression (ax^2+bx+c) to find the zeros of the function it represents. I can identify and factor perfect-square trinomials. I can complete the square to rewrite a quadratic expression (ax^2+bx+c) with the form $a(x-h)^2+k.$ I can identify the maximum or minimum of a quadratic written in the form $a(x-h)^2+k.$	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. **7. <u>Look for and make use of structure.</u>** 8. Look for and express regularity in repeated reasoning.	Quadratic expression Quadratic equation Zeros Perfect-square trinomial Complete the square Function Maximum Minimum
A.REI.4 Solve quadratic equations in one variable. a. 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. b. Solve quadratic equations as appropriate to the initial form of the equation by	I can identify a quadratic expression, $ax^2+bx+c.$ I can identify a perfect-square trinomial by first noticing if a and c are perfect squares and if $b=2ac.$ I can factor a perfect-square trinomial.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision.	Quadratic equation Complete the square Inspection Square root method Quadratic formula Factoring completely Perfect square trinomial

inspection(e.g $x^2 = 49$), taking square roots, completing the square, the quadratic formula,or utilizing the zero product property after factoring.	I can complete the square of $ax^2 + bx + c$ to write the quadratic in the form $(x - p)^2 = q$. I can derive the quadratic formula by completing the square of $ax^2 + bx + c$. I can determine the best method to solve a quadratic in one variable. I can solve quadratic equations by inspection. I can solve quadratic equations by finding square roots. I can solve quadratic equations by completing the square. I can solve quadratic equations by using the quadratic formula. I can solve quadratic equations by factoring.	**7. <u>Look for and make use of structure.</u>** 8. **<u>Look for and express regularity in repeated reasoning.</u>**	
N.CN.1 Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + b$ with a and b real.	Explain that i is defined as a number whose square is -1. Identify that every complex number can be written as a + bi, where a and b are real numbers.	1. Make sense of problems and persevere in solving them. **2. <u>Reason abstractly and quantitatively.</u>**	

	Define and distinguish between the real part (a) and imaginary part (b) of a complex number. Recognize i as the imaginary unit and explain why it was created Interpret complex numbers geometrically on the complex plane. Explain why complex numbers were developed to solve equations like $x^2 + 1 = 0$.	**3. Construct viable arguments and critique the reasoning of others.** 4. Model with mathematics. 5. Use appropriate tools strategically. **6. Attend to precision.** **7. Look for and make use of structure.** 8. Look for and express regularity in repeated reasoning.	
N.CN.7: Solve quadratic equations with real coefficients that have complex solutions.	Identify perfect square factors and simplify square roots of negative numbers using i. Write and simplify complex numbers in a + bi form, including adding, subtracting, and multiplying complex numbers. Use the quadratic formula to solve quadratic equations and recognize when solutions will be complex. Identify the type of solutions (two real, one real, two complex) based on discriminant value.	**9. Make sense of problems and persevere in solving them.** **10. Reason abstractly and quantitatively.** **11. Construct viable arguments and critique the reasoning of others.** **12. Model with mathematics.** **13. Use appropriate tools strategically.** **14. Attend to precision.** 15. Look for and make use of structure. 16. Look for and express regularity in repeated reasoning.	

	Write complex solutions in a + bi form and verify they are complex conjugates. Explain why complex solutions to quadratic equations with real coefficients occur in conjugate pairs. Use $i^2 = -1$ to simplify powers of i and expressions with complex numbers. Graph complex numbers on a complex coordinate plane and interpret their absolute value as distance from the origin. Convert between rectangular and polar forms of complex numbers. Apply complex numbers to solve real-world and mathematical problems.		
A.REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. *For example, find the points of intersection between the line* $y = -3x$ and the circle $x^2 + y^2 = 3$.	I can distinguish between equations that are linear and those that are quadratic. I can use substitution to solve a system of equations in which one equation is linear and one equation is quadratic. I can graph a linear equation on a coordinate plane.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically.	System of equations Linear equation Quadratic equation Substitution method Solution of a system Intersection

	I can graph a quadratic equation on a coordinate plane. I can determine the approximate solution of a system of equations in which one equation is linear and one equation is quadratic by graphing and estimating the point(s) of intersection.	6. Attend to precision. 7. Look for and make use of structure. **8. <u>Look for and express regularity in repeated reasoning.</u>**	

Statistics
S.ID.1; S.ID.2; S.ID.3; S.ID.5; S.ID.6; S.ID.7; S.ID.8

Enduring Understandings:

- Statisticians summarize, represent, and interpret categorical and quantitative data in multiple ways since one method can reveal or create a different impression than another.

Essential Questions:

- How can the properties of data be communicated to illuminate its important features?

Clusters:

- Summarize, represent, and interpret data on a single count or measurement variable.
- Interpret linear models.

Standard	Clear Learning Targets	Mathematical Practices	Vocabulary
Summarize, represent, and interpret data on a single count or measurement variable. S.ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots) in the context of real-world applications using the GAISE model.★	I can choose the best representation (dot plot, histogram, box plot) for a set of data. I can decided if a representation preserves all the data values or presents only the general characteristics of a data set. I can choose the appropriate scale to represent data on a number line. I can construct a dot plot for a set of data. I can construct a histogram for a set of data. I can calculate the 5-number summary for a set of data.	**1. <u>Make sense of problems and persevere in solving them.</u>** 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. **5. <u>Use appropriate tools strategically.</u>** 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Dot plot Histogram Box plot 5-number summary Median Lower quartile Upper quartile Minimum value Maximum value Data Frequency

	I can construct a box plot based on the 5 number summary.		Interval Scale
Summarize, represent, and interpret data on a single count or measurement variable. S.ID.2 In the context of real-world applications by using the GAISE model, use statistics appropriate to the shape of the data distribution to compare center (median and mean) and spread (mean absolute deviation, interquartile range, and standard deviation) of two or more different data sets. ★	I can describe the center of the data distribution (mean or median). I can choose the histogram with the largest mean when shown several histograms. I can describe the spread of the data distribution (interquartile range or standard deviation). I can choose the histogram with the greatest standard deviation when shown several histograms. I can choose the box-and-whisker plot with the greatest interquartile range when shown several box-and-whisker plots. I can compare the distributions of two or more data sets by examining their shapes, centers, and spreads when drawn on the same scale.	**1. <u>Make sense of problems and persevere in solving them.</u>** 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. **5. <u>Use appropriate tools strategically.</u>** 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Distribution Shape Center Spread Median Mean Interquartile range Standard deviation Data Data distribution Scale
Summarize, represent, and interpret data on a single count or measurement variable. S.ID.3 In the context of real-world applications by using the GAISE	I can interpret the differences in the shape, center, and spread of a data set in the context of a problem. I can identify outliers for the data set.	**1. <u>Make sense of problems and persevere in solving them.</u>** 2. Reason abstractly and quantitatively.	Shape Center Spread

model, interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). ★	I can predict the effect an outlier will have on the shape, center, and spread of a data set. I can decide whether to include the outliers as part of the data set or to remove them.	3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. **5. <u>Use appropriate tools strategically.</u>** 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Data set Distribution Outlier
S.ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (include joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.	I can read and interpret the data displayed in a two-way frequency table. I can write clear summaries of data displayed in a two-way frequency table. I can calculate percentages using ratios in a two-way frequency table to yield relative frequencies. I can calculate joint, marginal, and conditional relative frequencies. I can interpret and explain the meaning of relative frequencies in the context of the problem.	1. Make sense of problems and persevere in solving them. **2. <u>Reason abstractly and quantitatively.</u>** 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Data Two-way frequency table Percentages Ratios Relative frequencies Joint relative frequency Marginal relative frequency Conditional relative frequency Bar chart Patterns

	I can make appropriate displays of joint, marginal, and conditional distributions (e.g., bar chart, pie chart). I can describe patterns observed in the data. I can recognize the association between two variables by comparing conditional and marginal percentages.		Associations Variables
Summarize, represent, and interpret data on two categories and quantitative variables S.ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.★ c. Fit a linear function for a scatterplot that suggests a linear association. (A1, M1)	I can explain that scatter plots can only be used to represent quantitative variables. I can identify the independent variable and dependent variable and describe the relationship of the variables. I can construct a scatter plot with an appropriate scale. I can identify any outliers on the scatter plot. I can determine when linear model fits the data I can determine whether linear models are increasing or decreasing. I can sketch the function of best fit on the scatter plot.	1. Make sense of problems and persevere in solving them. **2. <u>Reason abstractly and quantitatively.</u>** 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>** 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Scatter plot Quantitative variable Independent variable Dependent variable Scale Direction Form Strength Outliers Linear Models

	I can use technology to find the function of best fit for a scatter plot. I can sketch a line of best fit on a scatter plot that appears linear. I can write the equation of the line of best fit $(y = mx + b)$ using technology or by using two points on the best fit line.		Data set Function of best fit Line of best fit $y = mx + b$
S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.	I can interpret the meaning of the slope in terms of the units stated in the data. I can interpret the meaning of the y-intercept in terms of the units stated in the data.	1. Make sense of problems and persevere in solving them. **2. <u>Reason abstractly and quantitatively.</u>** 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>** **5. <u>Use appropriate tools strategically.</u>** 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Slope y-intercept Linear equation Linear model Units Data
S.ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.	I can explain that correlation coefficient applies only to quantitative variables and linear models of best fit.	1. Make sense of problems and persevere in solving them.	Correlation coefficient Quantitative variable

	I can explain that the correlation coefficient must be between -1 and 1 inclusive and explain what each of these values means. I can explain the correlation coefficient as a measure of the "goodness of a linear fit". I can compute the correlation coefficient (r) using a graphing calculator or other appropriate technology. I can use the correlation coefficient to interpret the linear model in terms of its sign (i.e., direction) and its magnitude (i.e., strength). I can use the correlation coefficient to determine if a linear model is a good fit for the data (significance).	2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. **4. <u>Model with mathematics.</u>** **5. <u>Use appropriate tools strategically.</u>** 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	Linear model of best fit

Assessment of Learning Options

- Summative Assessments
- Formative Assessments

Resources

Ohio Department of Education Algebra 1 Model Curriculum with Instructional Supports

"The Common Core: Clarifying Expectations for Teachers & Students." *MATH Grades 9-12*. Worthington: 2011. <http://www.qualityinstruction.org>.

Common Core State Standards: Mathematics

Standards for Mathematical Practices Progression through Grade Levels

Kansas Teachers of Mathematics Flipbook