COURSE: Mathematics **LEVEL**: Grade 8 **UNIT/FOCUS**: Linear Systems

Desired Results

Related standard(s):

8.EE.5
8.EE.6
8.EE.7a
8.EE.7b
8.EE.8a
8.EE.8b
8.EE.8c
8.F.4
8.F.5
A-SSE.1a
A-CED.2
A-CED.3
A-REI.4a
A-REI.4b
A-REI.5
A-REI.6
A-REI.10
A-REI.11
A-REI.12

Transfer

Students will be able to independently use their learning to…

- Create models using the connections between proportional relationships, lines, and linear equations.
- Analyze and solve linear equations and pairs of simultaneous linear equations.
- Use functions to model relationships between quantities.
- Interpret the structure of expressions.
- Create equations that describe numbers or relationships.
- Solve equations and inequalities in one variable.
- Solve systems of equations.
- Represent and solve equations and inequalities graphically.

Meaning

Enduring Understandings (EUs)	Essential Questions (EQs)
Students will understand that…	*Students will keep considering…*
• The use and manipulation of symbols and expressions provide a variety or representations for solving problems and expressing mathematical concepts, relationships, and reasoning. • Understandings of number – "how many" or "how much" – and number types extend applications of arithmetic properties, operations, and number systems and guide the use of computational strategies and algorithms. • Measurement attributes, processes, and tools, help us to quantify, compare, and solve problems involving objects, situations, and events. • Patterns, relations, and functions are used to represent and analyze change in various contexts, make predictions and generalizations, and provide models and explanations for real-world problems. • Visualizations, spatial reasoning, and properties of two- and three- dimensional figures can be used to analyze, represent, and model geometric concepts and relationships. • Questions are posed and investigated by collecting data or retrieving existing data, and representing, analyzing, and interpreting data. Investigations, inferences, and predictions are used to make critical and informed decisions.	• How are symbols and expressions utilized as representations in mathematics? • In what ways can a quantity be represented? • In what ways is measurement useful? • How can I use patterns, relations, and functions? • How are geometric concepts and relations conceptualized? • What roles can data play in the decision making process?

	Grade Level Benchmarks	
	Knowledge	Skills
	Students will know… • A solution of a linear system is an ordered pair that must satisfy each equation in a system. • Consistent independent describes a system with one solution. • Consistent dependent describes a system with infinitely many solutions. • Inconsistent/coincident lines describe a system with no solution (parallel lines). • The solutions for systems of inequalities are where shading overlaps. • There are only two types of solutions for systems of inequalities: infinitely many or none.	*Students will be able to…* • Find solutions of systems through graphing. • Find solutions of systems through substitution. • Find solutions of systems through multiplication-addition algorithm. • Determine if a system has one, none, or infinitely many solutions. • Graph and find solutions for systems of inequalities. • Use graphing calculator to graph systems of inequalities.

TASKS from CCSS for *Linear Systems*

8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.

8.EE.6 Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at b.

8.EE.7. Solve linear equations in one variable.

a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form x = a, a = a, or a = b results (where a and b are different numbers).

b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.

8.EE.8. Analyze and solve pairs of simultaneous linear equations.

a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.

b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, 3x + 2y = 5 and 3x + 2y = 6 have no solution because 3x + 2y cannot simultaneously be 5 and 6.

c. Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

8.F.4. Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

8.F.5. Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

A-SSE.1. Interpret expressions that represent a quantity in terms of its context.★

a. Interpret parts of an expression, such as terms, factors, and coefficients.

A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

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.

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. Derive the quadratic formula from this form.

b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.

A-REI.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

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).

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 approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

A-REI.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.

COURSE: Mathematics **LEVEL**: Grade 8 **UNIT/FOCUS**: Exponents

Desired Results

Related standard(s):

8.NS.1
8.NS.2
8.EE.1
8.EE.2
8.EE.3
8.EE.4
A-SSE.1b
A-SSE.2
A-SSE.3c
A-SSE.4
A-REI.11

Transfer

Students will be able to independently use their learning to…

- Approximate irrational numbers using rational numbers.
- Work with radicals and integer exponents.
- Interpret the structure of expressions.
- Write expressions in equivalent forms to solve problems.
- Represent and solve equations and inequalities graphically.

Meaning

Enduring Understandings (EUs)	Essential Questions (EQs)
Students will understand that…	*Students will keep considering…*
• The use and manipulation of symbols and expressions provide a variety or representations for solving problems and expressing mathematical concepts, relationships, and reasoning. • Understandings of number – "how many" or "how much" – and number types extend applications of arithmetic properties, operations, and number systems and guide the use of computational strategies and algorithms. • Measurement attributes, processes, and tools, help us to quantify, compare, and solve problems involving objects, situations, and events. • Patterns, relations, and functions are used to represent and analyze change in various contexts, make predictions and generalizations, and provide models and explanations for real-world problems. • Visualizations, spatial reasoning, and properties of two- and three- dimensional figures can be used to analyze, represent, and model geometric concepts and relationships. • Questions are posed and investigated by collecting data or retrieving existing data, and representing, analyzing, and interpreting data. Investigations, inferences, and predictions are used to make critical and informed decisions.	• How are symbols and expressions utilized as representations in mathematics? • In what ways can a quantity be represented? • In what ways is measurement useful? • How can I use patterns, relations, and functions? • How are geometric concepts and relations conceptualized? • What roles can data play in the decision making process?

	Grade Level Benchmarks	
	Knowledge	Skills
	Students will know… • Compound interest is interest that earns interest. • Simple interest is a linear function; compound interest is an exponential function. • Constant increase is in the form of $y = mx + b$; where b is your initial value; and m is your slope/constant increase x number of times. • Exponential growth is modeled by the equation $y = b * g^x$; where b is your initial value; g is the growth rate factor/percent change greater than 1; and x is the number of time periods. • Exponential decay is modeled by the equation $y = b * g^x$; where b is your initial value; g is the growth rate factor/percent change greater than 0, but less than 1; and x is the number of time periods. • The seven properties of powers: zero exponent; negative exponent; product of powers; quotient of powers; power of a power; power of a product; and power of a quotient.	*Students will be able to…* • Evaluate integer powers of real numbers. • Simplify products, quotients, and powers of power. • Apply properties of exponents to simplify expressions. • Solve problems involving exponential growth and decay. • Calculate compound interest. • Write and graph exponential functions. • Graph and compare simple and compound interests by hand and graphing calculator.

TASKS from CCSS for *Exponents*

8.NS.1. Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal expansion which repeats eventually into a rational number.

8.NS.2. Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., π2). For example, by truncating the decimal expansion of √2, show that √2 is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations

8.EE.1. Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example, $3^2 \times 3^{-5} = 3^{-3} = 1/3^2 = 1/27$.

8.EE.2. Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational.

8.EE.3. Use numbers expressed in the form of a single digit times a whole-number power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. For example, estimate the population of the United States as 3 times 108 and the population of the world as 7 times 109, and determine that the world population is more than 20 times larger.

8.EE.4. Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

A-SSE.1. Interpret expressions that represent a quantity in terms of its context.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)n as the product of P and a factor not depending on P.

A-SSE.2. Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.

A-SSE.3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as $(1.151/12)12t \approx 1.01212t$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

A-SSE.4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.

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 approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

COURSE: Mathematics **LEVEL**: Grade 8 **UNIT/FOCUS**: Polynomials

Desired Results

Related standard(s):

8.G.9
A-SSE.2
A-APR.1
A-APR.4
A-APR.5

Transfer

Students will be able to independently use their learning to…

- Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.
- Interpret the structure of expressions.
- Perform arithmetic operations on polynomials.
- Understand the relationship between zeros and factors of polynomials.
- Use polynomial identities to solve problems.

Meaning

Enduring Understandings (EUs)	Essential Questions (EQs)
Students will understand that…	*Students will keep considering…*
• The use and manipulation of symbols and expressions provide a variety or representations for solving problems and expressing mathematical concepts, relationships, and reasoning. • Understandings of number – "how many" or "how much" – and number types extend applications of arithmetic properties, operations, and number systems and guide the use of computational strategies and algorithms. • Measurement attributes, processes, and tools, help us to quantify, compare, and solve problems involving objects, situations, and events. • Patterns, relations, and functions are used to represent and analyze change in various contexts, make predictions and generalizations, and provide models and explanations for real-world problems. • Visualizations, spatial reasoning, and properties of two- and three- dimensional figures can be used to analyze, represent, and model geometric concepts and relationships. • Questions are posed and investigated by collecting data or retrieving existing data, and representing, analyzing, and interpreting data. Investigations, inferences, and predictions are used to make critical and informed decisions.	• How are symbols and expressions utilized as representations in mathematics? • In what ways can a quantity be represented? • In what ways is measurement useful? • How can I use patterns, relations, and functions? • How are geometric concepts and relations conceptualized? • What roles can data play in the decision making process?

	Grade Level Benchmarks	
	Knowledge	Skills
	Students will know… • A polynomial is an expression of many terms. • There a variety of ways to multiply polynomials. • FOIL is the distributive property using two terms (*F*irst, *O*utside, *I*nside, *L*ast). • Binomial has two terms; and a trinomial has three terms. • Degree of a monomial is the sum of the exponents of the variables in the expression. • Standard form of a polynomial is when the exponents are in descending order. • Perfect square patterns and difference of two squares patterns.	*Students will be able to…* • Add and subtract polynomials. • Translate investment situations into polynomials. • Multiply polynomials. • Classify polynomials by degree and term. • Multiply binomials. • Model polynomial multiplication using area. • Square a binomial. • Multiply a binomial by its opposite; multiply the sum of (a + b) by its difference (a – b).

TASKS from CCSS for *Polynomials*

8.G.9. Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

A-SSE.2. Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.

A-APR.1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

A-APR.4. Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.

A-APR.5. (+) Know and apply the Binomial Theorem for the expansion of (x + y)n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.1

COURSE: Mathematics **LEVEL**: Grade 8 **UNIT/FOCUS**: Factoring

Desired Results

Related standard(s):

A-SSE.2
A-APR.3
A-APR.4
A-APR.5
A-APR.6
A-APR.7
A-REI.2

Transfer

Students will be able to independently use their learning to…

- Interpret the structure of expressions.
- Perform arithmetic operations on polynomials.
- Relate zeros and factors of polynomials.
- Use polynomial identities to solve problems.
- Rewrite rational expressions.
- Explain the reasoning used to solve equations.

Meaning

Enduring Understandings (EUs)	Essential Questions (EQs)
Students will understand that…	*Students will keep considering…*
• The use and manipulation of symbols and expressions provide a variety or representations for solving problems and expressing mathematical concepts, relationships, and reasoning. • Understandings of number – "how many" or "how much" – and number types extend applications of arithmetic properties, operations, and number systems and guide the use of computational strategies and algorithms. • Measurement attributes, processes, and tools, help us to quantify, compare, and solve problems involving objects, situations, and events. • Patterns, relations, and functions are used to represent and analyze change in various contexts, make predictions and generalizations, and provide models and explanations for real-world problems. • Visualizations, spatial reasoning, and properties of two- and three- dimensional figures can be used to analyze, represent, and model geometric concepts and relationships. • Questions are posed and investigated by collecting data or retrieving existing data, and representing, analyzing, and interpreting data. Investigations, inferences, and predictions are used to make critical and informed decisions.	• How are symbols and expressions utilized as representations in mathematics? • In what ways can a quantity be represented? • In what ways is measurement useful? • How can I use patterns, relations, and functions? • How are geometric concepts and relations conceptualized? • What roles can data play in the decision making process?

Grade Level Benchmarks	
Knowledge	Skills
Students will know… • Factoring reverses polynomial multiplication. • Solutions to a quadratic equation through factoring are the roots or x-intercepts of the graph. • All quadratic equations cannot be factored. • Signs in the quadratic equations dictate the signs in the factored binomials. • If the product of two factors is zero, then one factor must be zero. • Factoring a quadratic equation is done in a variety of ways. • If a positive integer is not a perfect square, then its square root is an irrational number.	*Students will be able to…* • Factor greatest common factor. • Factor positive integers into primes by factorization. • Factor quadratic equations into the product of two binomials. • Solve quadratic equations through factoring. • Solve using the zero-product property. • Determine if a quadratic equation can be factored. • Determine if roots of real numbers are rational or irrational.

TASKS from CCSS for *Factoring*

A-SSE.2. Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.

A-APR.3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

A-APR.4. Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.

A-APR.5. (+) Know and apply the Binomial Theorem for the expansion of (x + y)n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.1

A-APR.6. Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) +r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

A-APR.7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

A-REI.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

COURSE: Mathematics **LEVEL**: Grade 8 **UNIT/FOCUS**: Quadratics

Desired Results

Related standard(s):

8.NS.1
8.NS.2
8.EE.1
8.EE.2
8.EE.3
8.EE.4
A-SSE.3a
A-SSE.3b
A-APR.3
A-REI.11

Transfer

Students will be able to independently use their learning to…

- Approximate irrational numbers using rational numbers.
- Work with radicals and integer exponents.
- Write expressions in equivalent forms to solve problems.
- Relate zeros and factors of polynomials.
- Represent and solve equations and inequalities graphically.

Meaning

Enduring Understandings (EUs)	Essential Questions (EQs)
Students will understand that…	*Students will keep considering…*
• The use and manipulation of symbols and expressions provide a variety or representations for solving problems and expressing mathematical concepts, relationships, and reasoning. • Understandings of number – "how many" or "how much" – and number types extend applications of arithmetic properties, operations, and number systems and guide the use of computational strategies and algorithms. • Measurement attributes, processes, and tools, help us to quantify, compare, and solve problems involving objects, situations, and events. • Patterns, relations, and functions are used to represent and analyze change in various contexts, make predictions and generalizations, and provide models and explanations for real-world problems. • Visualizations, spatial reasoning, and properties of two- and three- dimensional figures can be used to analyze, represent, and model geometric concepts and relationships. • Questions are posed and investigated by collecting data or retrieving existing data, and representing, analyzing, and interpreting data. Investigations, inferences, and predictions are used to make critical and informed decisions.	• How are symbols and expressions utilized as representations in mathematics? • In what ways can a quantity be represented? • In what ways is measurement useful? • How can I use patterns, relations, and functions? • How are geometric concepts and relations conceptualized? • What roles can data play in the decision making process?

Grade Level Benchmarks

Knowledge	Skills
Students will know…	*Students will be able to…*
• A quadratic equation is in the form of: $y = ax^2 + bx + c$; where *a* determines if the graph opens up or down, and if it is wide or narrow. • A quadratic equation has a degree equal to two. • The solution(s) to a quadratic equation is also called your roots. • The roots are the x-intercepts of the graph. • Pattern is determined by a * 1, a * 3, and a * 5. • When graphing $y = ax^2$, the vertex is always at the origin. • To find the axis of symmetry, calculate the opposite of *b/2a*, which is also the x-value of the vertex. • Vertex of a parabola is the point of direction change in the graph. • Projectile motion describes the path of an object in space. • A quadratic equation has one, two, or no solutions. • The discriminant is the value inside the radical of the quadratic formula; if the discriminant is: < 0, there is no solution; = 0, there is one solution; or > 0, there are two solutions. • The quadratic formula is: $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ (where *a, b,* and *c* are from the given quadratic equation).	• Identify and use properties of quadratic equations. • Graph quadratic equations. • Solve quadratic equations through graphing. • Determine direction and size of a parabola. • Using *a*, determine pattern of the graph from the vertex. • Find the vertex of a graph. • Simplify square roots. • Evaluate the quadratic formula to solve a quadratic equation. • Analyze equation to determine placement of the graph in a coordinate plane. • Calculate the vertex. • Write and solve quadratic equations for paths of projectiles. • Calculate the discriminant to determine number of solutions to a quadratic equation. • Use graphing calculator to evaluate quadratic formula and graph quadratic equations.

TASKS from CCSS for *Quadratics*

8.NS.1. Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal expansion which repeats eventually into a rational number.

8.NS.2. Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., π2). For example, by truncating the decimal expansion of √2, show that √2 is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations

8.EE.1. Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example, $3^2 \times 3^{-5} = 3^{-3} = 1/3^2 = 1/27$.

8.EE.2. Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational.

8.EE.3. Use numbers expressed in the form of a single digit times a whole-number power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. For example, estimate the population of the United States as 3 times 108 and the population of the world as 7 times 109, and determine that the world population is more than 20 times larger.

8.EE.4. Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

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.

A-APR.3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

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 approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

COURSE: Mathematics **LEVEL**: Grade 8 **UNIT/FOCUS**: Non-Linear Functions

Desired Results

Related standard(s):

8.NS.1
8.NS.2
8.EE.1
8.EE.2
8.EE.3
8.EE.4
8.G.6
8.G.7
8.G.8
A-SSE.4
A-APR.6
A-APR.7
A-REI.2
A-REI.11

Transfer

Students will be able to independently use their learning to…

- Approximate irrational numbers using rational numbers.
- Work with radicals and integer exponents.
- Write expressions in equivalent forms to solve problems.
- Apply the Pythagorean Theorem.
- Write expressions in equivalent forms to solve problems.
- Rewrite rational expressions.
- Explain the reasoning used to solve equations.
- Represent and solve equations and inequalities graphically.

Meaning

Enduring Understandings (EUs)	Essential Questions (EQs)
Students will understand that…	*Students will keep considering…*
• The use and manipulation of symbols and expressions provide a variety or representations for solving problems and expressing mathematical concepts, relationships, and reasoning. • Understandings of number – "how many" or "how much" – and number types extend applications of arithmetic properties, operations, and number systems and guide the use of computational strategies and algorithms. • Measurement attributes, processes, and tools, help us to quantify, compare, and solve problems involving objects, situations, and events. • Patterns, relations, and functions are used to represent and analyze change in various contexts, make predictions and generalizations, and provide models and explanations for real-world problems. • Visualizations, spatial reasoning, and properties of two- and three- dimensional figures can be used to analyze, represent, and model geometric concepts and relationships. • Questions are posed and investigated by collecting data or retrieving existing data, and representing, analyzing, and interpreting data. Investigations, inferences, and predictions are used to make critical and informed decisions.	• How are symbols and expressions utilized as representations in mathematics? • In what ways can a quantity be represented? • In what ways is measurement useful? • How can I use patterns, relations, and functions? • How are geometric concepts and relations conceptualized? • What roles can data play in the decision making process?

	Grade Level Benchmarks	
	Knowledge	Skills
	Students will know… • A function is a set of ordered pairs in which each first coordinate appears with exactly one second coordinate. • F(x) is read the function of x (do not mean multiplication). • An absolute value graph is in the shape of a "v." • Coefficients in an absolute value equation mimic actions of the coefficients of a quadratic equation and the graphs. • Domain is the input value/x-value of a function. • Range is the output value/y-value. • Functions can have restricted domains and ranges. • Non-linear functions do not have a constant rate of change. • A solution to a rational equation may not always work if it sets the denominator equal to zero.	*Students will be able to…* • Evaluate functions. • Solve equations involving function notation f(x). • Graph functions. • Identify a function. • Identify domain and range of functions. • Predict size and shape of graphs of functions. • Simplify radical expressions. • Identify restricted values of rational functions. • Simplify rational expressions. • Add, subtract, multiply, and divide rational expressions. • Solve rational equations and identify extraneous solutions. • Use function keys on a calculator. • Graph non-linear functions on a graphing calculator.

TASKS from CCSS for *Non-Linear Functions*

8.NS.1. Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal expansion which repeats eventually into a rational number.

8.NS.2. Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., π2). For example, by truncating the decimal expansion of √2, show that √2 is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations

8.EE.1. Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example, $32 \times 3^{-5} = 3^{-3} = 1/33 = 1/27$.

8.EE.2. Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational.

8.EE.3. Use numbers expressed in the form of a single digit times a whole-number power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. For example, estimate the population of the United States as 3 times 108 and the population of the world as 7 times 109, and determine that the world population is more than 20 times larger.

8.EE.4. Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

8.G.6. Explain a proof of the Pythagorean Theorem and its converse.

8.G.7. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

8.G.8. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

A-SSE.4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.

A-APR.6. Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) +r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

A-APR.7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

A-REI.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

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 approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.