



ESL
SCIENCE
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RAHWAY PUBLIC SCHOOLS

CURRICULUM & INSTRUCTION

Content Area: Mathematics

Course: Algebra II & Algebra II Honors

Grade Level: 9-12

This curriculum is part of the Educational Program of Studies of the Rahway Public Schools.

ACKNOWLEDGMENTS

Jeffery Kurczeski,

Program Supervisor of 7-12 Math & Science and 9-12 Business & Technology Education

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Toni Robertelli, Mathematics Teacher

Anna Winters, Mathematics Teacher

Dr. Tiffany A. Beer, Director of Curriculum and Instruction

Dr. Aleya Shoieb, Superintendent of Schools

Subject/Course Title:
Algebra II & Algebra II Honors
Grades 9-12

Date of Board Adoption:
August 27, 2024

RAHWAY PUBLIC SCHOOLS CURRICULUM

Algebra II & Algebra II Honors: Grades 9-12

PACING GUIDE

Unit	Title	Pacing
1	Linear & Quadratics Functions	10 weeks
2	Complex Numbers & Solving Quadratics; Polynomial Functions	11 weeks
3	Other Functions - Rational Exponents & Radicals; Exponential & Logarithms	11 weeks
4	Rational Functions; Probability, Statistics & Data Analysis; Trigonometry & Unit Circle (Honors Only)	8 weeks

ACCOMMODATIONS

<p>504 Accommodations:</p> <ul style="list-style-type: none"> ● Provide scaffolded vocabulary and vocabulary lists. ● Provide extra visual and verbal cues and prompts. ● Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials. ● Provide links to audio files and utilize video clips. ● Provide graphic organizers and/or checklists. ● Provide modified rubrics. ● Provide a copy of teaching notes, especially any key terms, in advance. ● Allow additional time to complete assignments and/or assessments. ● Provide shorter writing assignments. ● Provide sentence starters. ● Utilize small group instruction. ● Utilize Think-Pair-Share structure. ● Check for understanding frequently. ● Have student restate information. ● Support auditory presentations with visuals. ● Weekly home-school communication tools (notebook, daily log, phone calls or email messages). ● Provide study sheets and teacher outlines prior to assessments. ● Quiet corner or room to calm down and relax when anxious. ● Reduction of distractions. ● Permit answers to be dictated. ● Hands-on activities. ● Use of manipulatives. ● Assign preferential seating. ● No penalty for spelling errors or sloppy handwriting. ● Follow a routine/schedule. ● Provide student with rest breaks. ● Use verbal and visual cues regarding directions and staying on task. ● Assist in maintaining agenda book. 	<p>IEP Accommodations:</p> <ul style="list-style-type: none"> ● Provide scaffolded vocabulary and vocabulary lists. ● Differentiate reading levels of texts (e.g., Newsela). ● Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials. ● Provide extra visual and verbal cues and prompts. ● Provide links to audio files and utilize video clips. ● Provide graphic organizers and/or checklists. ● Provide modified rubrics. ● Provide a copy of teaching notes, especially any key terms, in advance. ● Provide students with additional information to supplement notes. ● Modify questioning techniques and provide a reduced number of questions or items on tests. ● Allow additional time to complete assignments and/or assessments. ● Provide shorter writing assignments. ● Provide sentence starters. ● Utilize small group instruction. ● Utilize Think-Pair-Share structure. ● Check for understanding frequently. ● Have student restate information. ● Support auditory presentations with visuals. ● Provide study sheets and teacher outlines prior to assessments. ● Use of manipulatives. ● Have students work with partners or in groups for reading, presentations, assignments, and analyses. ● Assign appropriate roles in collaborative work. ● Assign preferential seating. ● Follow a routine/schedule.
<p>Gifted and Talented Accommodations:</p> <ul style="list-style-type: none"> ● Differentiate reading levels of texts (e.g., Newsela). ● Offer students additional texts with higher lexile levels. ● Provide more challenging and/or more supplemental readings and/or activities to deepen understanding. ● Allow for independent reading, research, and projects. ● Accelerate or compact the curriculum. ● Offer higher-level thinking questions for deeper analysis. ● Offer more rigorous materials/tasks/prompts. ● Increase number and complexity of sources. ● Assign group research and presentations to teach the class. ● Assign/allow for leadership roles during collaborative work and in other learning activities. 	<p>ML Accommodations:</p> <ul style="list-style-type: none"> ● Provide extended time. ● Assign preferential seating. ● Assign peer buddy who the student can work with. ● Check for understanding frequently. ● Provide language feedback often (such as grammar errors, tenses, subject-verb agreements, etc...). ● Have student repeat directions. ● Make vocabulary words available during classwork and exams. ● Use study guides/checklists to organize information. ● Repeat directions. ● Increase one-on-one conferencing. ● Allow student to listen to an audio version of the text. ● Give directions in small, distinct steps. ● Allow copying from paper/book. ● Give student a copy of the class notes.

- Provide written and oral instructions.
- Differentiate reading levels of texts (e.g., Newsela).
- Shorten assignments.
- Read directions aloud to student.
- Give oral clues or prompts.
- Record or type assignments.
- Adapt worksheets/packets.
- Create alternate assignments.
- Have student enter written assignments in criterion, where they can use the planning maps to help get them started and receive feedback after it is submitted.
- Allow student to resubmit assignments.
- Use small group instruction.
- Simplify language.
- Provide scaffolded vocabulary and vocabulary lists.
- Demonstrate concepts possibly through the use of visuals.
- Use manipulatives.
- Emphasize critical information by highlighting it for the student.
- Use graphic organizers.
- Pre-teach or pre-view vocabulary.
- Provide student with a list of prompts or sentence starters that they can use when completing a written assignment.
- Provide audio versions of the textbooks.
- Highlight textbooks/study guides.
- Use supplementary materials.
- Give assistance in note taking
- Use adapted/modified textbooks.
- Allow use of computer/word processor.
- Allow student to answer orally, give extended time (time-and-a-half).
- Allow tests to be given in a separate location (with the ESL teacher).
- Allow additional time to complete assignments and/or assessments.
- Read question to student to clarify.
- Provide a definition or synonym for words on a test that do not impact the validity of the exam.
- Modify the format of assessments.
- Shorten test length or require only selected test items.
- Create alternative assessments.
- On an exam other than a spelling test, don't take points off for spelling errors.

UNIT 1 OVERVIEW

Content Area: Mathematics

Unit Title: Linear & Quadratics Functions

Target Course/Grade Level: Algebra II & Algebra II Honors/Grades 9-12

Unit Summary: This unit will focus on transformations of functions, and building new functions from existing functions, a topic that students explored in Algebra I using a variety of functions. The goal is to identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $kf(x)$, $f(kx)$, and $f(x + k)$ for specific values of k . Modeling with linear functions and solving linear systems in three variables are also included in this chapter. Also, during this unit students will focus on understanding characteristics of quadratic functions and writing equations of parabolas. Modeling with quadratic functions and graphing transformations of quadratic functions is also included in this chapter.

Approximate Length of Unit: 10 weeks

LEARNING TARGETS

NJ Student Learning Standards:

F.BF.B.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $kf(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F.IF.B.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

F.IF.B.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

F.IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

F.IF.C.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

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

A.CED.A.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.C.6** Solve systems of linear equations algebraically (include using the elimination method) and graphically, focusing on pairs of linear equations in two variables.
- A.REI.C.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 $x^2 + y^2 = 3$.
- N.Q.A.2** Define appropriate quantities for the purpose of descriptive modeling.
- S.ID.A.1** Represent data with plots on the real number line (dot plots, histograms, and box plots).
- S.ID.A.2** Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

Career Readiness, Life Literacies, and Key Skills:

- 9.4.12.CI.1** Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
- 9.4.12.CT.1** Identify problem-solving strategies used in the development of an innovative product or practice.
- 9.4.12.CT.2** Explain the potential benefits of collaborating to enhance critical thinking and problem solving.
- 9.4.12.IML.2** Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.
- 9.4.12.TL.1** Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

Interdisciplinary Connections and Standards:

ELA

- RI.CR.11–12.1** Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text.
- L.SS.11–12.1** Demonstrate command of the system and structure of the English language when writing or speaking.
- L.VL.11–12.3** Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, including technical meanings, choosing flexibly from a range of strategies.
- W.AW.11–12.1** Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
- W.IW.11–12.2** Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
- W.WR.11–12.5** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- W.RW.11–12.7** Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes.
- SL.PE.11–12.1** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
- SL.II.11–12.2** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
- SL.PI.11–12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.
- SL.AS.11–12.6** Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.

Science

HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Unit Understandings:

Students will understand...

- Building new functions from existing functions.
- Interpreting functions that arise in applications in terms of the context.
- Analyzing functions using different representations.
- Creating equations that describe numbers or relationships.
- Solving systems of equations.
- Reasoning quantitatively and using units to solve problems.

Unit Essential Questions:

- What are the characteristics of some of the basic parent functions?
- How do the graphs of $y = f(x) + k$, $y = f(x - h)$, and $y = -f(x)$ compare to the graph of the parent function f ?
- How can you use a linear function to model and analyze a real-life situation?
- How can you determine the number of solutions of a linear system?
- How do the constants a , h , and k affect the graph of the quadratic function $g(x) = a(x - h)^2 + k$?
- How can you use a quadratic function to model a real-life situation?

Knowledge and Skills:

Students will know...

- Graphing and describing transformations of functions.
- Writing functions that represent transformations of functions.
- Utilizing linear functions to model and analyze real-life situations.
- Solving linear systems in three variables.
- Linear equations in all forms (slope-intercept form, point-slope form, standard form).
- How to describe and graph transformations of quadratic functions.
- Graphing and describing quadratic functions in standard form, vertex form, and intercept form.
- Maximum & minimum values of quadratic functions.
- Graphing and writing equations of parabolas in standard form, vertex form, and intercept form.
- Writing equations of quadratic functions using given characteristics.
- Properties of parabolas (vertex, axis of symmetry, focus, directrix, etc.).
- Systems of equations in three variables algebraically.
- Vocabulary: parent function, transformation, translation, reflection, vertical stretch, vertical shrink, line of fit, line of best fit, correlation coefficient, linear equations in three variables, ordered triple, quadratic function, parabola, vertex, axis of symmetry, minimum value, maximum value, and end behavior.

Students will be able to...

- Identify parent functions and transformations.
- Describe transformations of parent functions.
- Model with linear functions.
- Solve linear systems.
- Argue how translations, reflections, stretches, and shrinks affect graphs of functions.
- Write functions that represent transformations of linear and absolute value functions.
- Compare and contrast linear equations to solve real-life problems.
- Solve real-life problems using systems of equations in three variables.
- Describe transformations of quadratic functions.
- Identify characteristics of quadratic functions.

- Write equations of parabolas.
- Model with quadratic functions.
- Write functions that represent transformations of quadratic functions.
- Utilize characteristics of quadratic functions to solve real-life problems.
- Illustrate quadratic equations to model data sets.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly “understand”?

- End of Unit Common Assessment - See folder for assessment links.
- Formative: warm-up activities, exploratory activities, class discussions, student participation, homework, and exit tickets.
- Summative: quizzes, tests, projects, and benchmark assessments.
- Open-ended problems that involve written responses with justification of answers.
- Renaissance Star Math Diagnostic Assessment – Fall, Winter, Spring

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Interactive Platforms: Desmos, Kahoot, Delta Math, Formative, Quizizz, Quizlet, Google Forms, Mathspace, PearDeck, Freckle, Geogebra, Gimkit, and Khan Academy.
- Group Work Suggestion: quiz trade, circuits, limit war, matching card games, jeopardy, relay review, and speed dating.
- **Sample Application Activities:**
 - Students apply their understanding of linear systems in three variables to determine the minimum flapping frequency needed for a robot to take flight.
 - Students apply their understanding of parabolas to write and graph an equation that represents the parabolic cross-sector of a parabolic radio telescope.

RESOURCES

Teacher Resources:

- **Textbook:** Larson, R. and Boswell, L. (2022). Algebra 2. Erie, PA: Big Ideas Learning, LLC.
- Useful Websites for Teachers to Utilize:
 - www.illustrativemathematics.org
 - <http://www.ixl.com>
 - www.kutasoftware.com
 - <https://www.khanacademy.org/>
 - <https://learnzillion.com/>
 - <https://www.teachingchannel.org/>
 - <http://illuminations.nctm.org>

Equipment Needed:

- Projector, Computer/Laptop, Chromebooks, Document Camera, Graphing Calculator

UNIT 2 OVERVIEW

Content Area: Mathematics

Unit Title: Complex Numbers & Solving Quadratics; Polynomial Functions

Target Course/Grade Level: Algebra II & Algebra II Honors/Grades 9-12

Unit Summary: This unit will focus on solving quadratic equations and inequalities, which may include imaginary solutions. Complex numbers are introduced after students review several methods they used in Algebra 1 to solve quadratic equations with real solutions. Students will also refresh and extend their understanding of solving nonlinear systems of equations. This unit will also extend students' knowledge of linear and quadratic functions to other polynomial functions. Students will graph polynomial functions and write and solve polynomial equations.

Approximate Length of Unit: 11 weeks

LEARNING TARGETS

NJ Student Learning Standards:

N.CN.A.1 Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.

N.CN.A.2 Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

N.CN.C.7 Solve quadratic equations with real coefficients that have complex solutions.

N.CN.C.8 Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$.

N.CN.C.9 Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

F.BF.B.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F.IF.B.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

F.IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

F.IF.C.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

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.

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

- A.APR.B.2** Know and apply the Remainder Theorem: For a polynomial $p(x)$ and a number a , the remainder on division by $x - a$ is $p(a)$, so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$.
- A.APR.B.3** Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.
- A.APR.C.4** Prove polynomial identities and use them to describe numerical relationships. For example, the difference of two squares; the sum and difference of two cubes; the polynomial identity $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.
- A.APR.C.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.
- A.APR.D.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.CED.A.1** Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
- A.CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- A.CED.A.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.D.11** Explain why the x -coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.
- A.SSE.A.2** Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.
- S.ID.A.3** Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
- S.ID.A.4** Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

Career Readiness, Life Literacies, and Key Skills:

- 9.4.12.CI.1** Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
- 9.4.12.CT.1** Identify problem-solving strategies used in the development of an innovative product or practice.
- 9.4.12.CT.2** Explain the potential benefits of collaborating to enhance critical thinking and problem solving.
- 9.4.12.IML.2** Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.
- 9.4.12.TL.1** Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

Interdisciplinary Connections and Standards:

ELA

- RI.CR.11–12.1** Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text.
- L.SS.11–12.1** Demonstrate command of the system and structure of the English language when writing or speaking.

- L.VL.11–12.3** Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, including technical meanings, choosing flexibly from a range of strategies.
- W.AW.11–12.1** Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
- W.IW.11–12.2** Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
- W.WR.11–12.5** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- W.RW.11–12.7** Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes.
- SL.PE.11–12.1** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
- SL.II.11–12.2** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
- SL.PI.11–12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.
- SL.AS.11–12.6** Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.

Science

- HS-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Unit Understandings:

Students will understand ...

- Performing arithmetic operations with complex numbers.
- Using complex numbers in polynomial identities and equations.
- Representing and solving polynomial equations and inequalities graphically.
- Creating equations that describe numbers or relationships.
- Performing arithmetic operations on polynomials.
- The relationship between zeros and factors of polynomials.
- Using polynomial identities to solve problems.
- Rewriting rational expressions.
- Interpreting the structure of expressions.

Unit Essential Questions:

- How can you use complex numbers?
- How can you derive a general formula for solving a quadratic equation?
- How can you solve a nonlinear system of equations?
- How can you solve a quadratic inequality?
- What are some common characteristics of the graphs of cubic and quartic polynomial functions?
- How can you perform operations on polynomials?
- How can you determine whether a polynomial equation has a repeated solution?
- How can you find a polynomial model for real-life data?

Knowledge and Skills:

Students will know...

- The quadratic equation and complex numbers.
- How to solve quadratic equations graphically and algebraically by completing the square and using the Quadratic Formula and discriminants.
- The imaginary unit i and performing operations with complex numbers.
- Solving nonlinear systems graphically and algebraically.
- How to graph quadratic inequalities in two variables and solve quadratic inequalities in one variable.
- How to graph and describe characteristics and transformations of polynomial functions.
- How to perform operations (adding, subtracting, and multiplying) on polynomials.
- How to divide polynomials by other polynomials using the Remainder Theorem.
- Factoring polynomials using the Factor Theorem.
- Solving polynomial equations and finding zeros of polynomial functions.
- The Fundamental Theorem of Algebra to find all complex roots of polynomial equations.
- How to write and analyze graphs of polynomial functions.
- Vocabulary: discriminant, Quadratic Formula, the imaginary unit “ i ”, complex numbers, systems of nonlinear equations, polynomial functions, end behavior & x-intercepts, turning points, local maximums & minimums, synthetic division, The Remainder Theorem, Factor Theorem, solutions of polynomial equations, The Rational Root Theorem, The Irrational Conjugates Theorem, The Fundamental Theorem of Algebra, and Descartes’ Rule of Signs.

Students will be able to...

- Perform operations with complex numbers.
- Solve quadratic equations by completing the square.
- Describe how to use the Quadratic Formula.
- Solve nonlinear systems and quadratic inequalities.
- Utilize quadratic equations to solve real-life problems.
- Predict complex solutions of quadratic equations and complex zeros of quadratic functions.
- Apply completing the square to write quadratic functions in vertex form.
- Write quadratic equations with different numbers of solutions using the discriminant.
- Examine graphing, substitution, and elimination as methods to solve nonlinear equations.
- Compare solving quadratic inequalities algebraically and graphically.
- Graph polynomial functions.
- Add, subtract, multiply, divide, and factor polynomials.
- Solve polynomial equations.
- Model with and analyze graphs of polynomial functions.
- Evaluate end behavior of polynomial functions.
- Utilize Pascal’s Triangle to expand binomials.
- Produce solutions to problems using the Remainder Theorem.
- Solve factoring polynomial problems using the Factor Theorem.
- Compose polynomial functions when given information about its zeros.
- Justify the Fundamental Theorem of Algebra.
- Write functions that represent transformations of polynomial functions.
- Analyze real zeros and turning points numerically.
- Utilize technology to find a polynomial model for a set of data.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly “understand”?

- End of Unit Common Assessment - See folder for assessment links.
- Formative: warm-up activities, exploratory activities, class discussions, student participation, homework, and exit tickets.
- Summative: quizzes, tests, projects, and benchmark assessments.
- Open-ended problems that involve written responses with justification of answers.
- Renaissance Star Math Diagnostic Assessment – Fall, Winter, Spring

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Interactive Platforms: Desmos, Kahoot, Delta Math, Formative, Quizizz, Quizlet, Google Forms, Mathspace, PearDeck, Freckle, Geogebra, Gimkit, and Khan Academy.
- Group Work Suggestion: quiz trade, circuits, limit war, matching card games, jeopardy, relay review, and speed dating.
- **Sample Application Activities:**
 - Students apply their understanding of modeling with quadratic functions and solving quadratic equations to make estimations and approximations about the number of operable nuclear reactors worldwide.
 - Students apply their understanding of modeling with polynomial functions to summarize how the number of wolves in Yellowstone National Park impacts the northern Yellowstone elk herd population.

RESOURCES

Teacher Resources:

- **Textbook:** Larson, R. and Boswell, L. (2022). Algebra 2. Erie, PA: Big Ideas Learning, LLC.
- Useful Websites for Teachers to Utilize:
 - www.illustrativemathematics.org
 - <http://www.ixl.com>
 - www.kutasoftware.com
 - <https://www.khanacademy.org/>
 - <https://learnzillion.com/>
 - <https://www.teachingchannel.org/>
 - <http://illuminations.nctm.org>

Equipment Needed:

- Projector, Computer/Laptop, Chromebooks, Document Camera, Graphing Calculator

UNIT 3 OVERVIEW

Content Area: Mathematics

Unit Title: Other Functions - Rational Exponents & Radicals; Exponential & Logarithms

Target Course/Grade Level: Algebra II & Algebra II Honors/Grades 9-12

Unit Summary: The focus of this unit is to understand rational exponents and radical functions. Students will extend their understanding of functions and equations to graph radical functions, solve radical equations, perform function operations, compose functions, and find inverses of functions. This unit will also extend students' knowledge of functions to exponential and logarithmic functions. Students will study the behavior, graphs, and real-life applications of exponential and logarithmic functions. Lastly, students will understand arithmetic and geometric sequences to include work with arithmetic and geometric series. Connections to linear and exponential functions are made throughout the unit.

Approximate Length of Unit: 11 weeks

LEARNING TARGETS

NJ Student Learning Standards:

N.RN.A.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.

For example, we define $5^{\frac{1}{3}}$ to be the cube root of 5 because we want $(5^{\frac{1}{3}})^3 = 5^{(\frac{1}{3})^3}$ to hold, so $(5^{\frac{1}{3}})^3$ must equal 5.

N.RN.A.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

N.RN.A.3 Simplify radicals, including algebraic radicals (e.g. $\sqrt[3]{54} = 3\sqrt[3]{2}$, simplify $\sqrt{32x^2}$).

F.BF.A.1 Write a function that describes a relationship between two quantities.

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.

c. Compose functions. For example, if $T(y)$ is the temperature in the atmosphere as a function of height, and $h(t)$ is the height of a weather balloon as a function of time, then $T(h(t))$ is the temperature at the location of the weather balloon as a function of time.

F.BF.A.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

F.BF.B.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F.BF.B.4 Find inverse functions.

a. Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse. For example, $f(x) = 2x^3$ or $f(x) = \frac{(x+1)}{(x-1)}$ for $x \neq 1$.

- F.IF.A.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 $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.
- F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
 - e. Graph exponential and logarithmic functions, showing intercepts and end behavior.
 - f. Graph trigonometric functions, showing period, midline, and amplitude.
- F.IF.C.8** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
- b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (.97)^t$, $y = (1.01)^{12t}$, $y = (1.01)^{t/10}$, and classify them as representing exponential growth or decay.
- F.LE.A.2** Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (including reading these from a table).
- F.LE.A.4** Understand the inverse relationship between exponents and logarithms. For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where a , c , and d are numbers and the base b is 2, 10, or e ; evaluate the logarithm using technology.
- F.LE.B.5** Interpret the parameters in a linear or exponential function in terms of a context.
- A.REI.A.1** Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
- A.REI.A.2** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
- A.REI.B.4** Solve quadratic equations in one variable.
- b. Solve quadratic equations by inspection (e.g., for $x^2 = 39$), 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.CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- A.CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law $V = IR$ to highlight resistance R .
- A.SSE.A.2** Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.
- A.SSE.B.3** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
- c. Use the properties of exponents to transform expressions for exponential functions. For example, the expression 1.15^t can be rewritten as $(1.15^{\frac{1}{12}})^{12t} \approx 1.012^{12t}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.
- A.SSE.B.4** Derive and/or explain 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.
- S.ID.B.5** Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.
- S.ID.B.6** Represent data on two quantitative variables on a scatter plot and describe how the variables are related.
- a. Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear and exponential models.

- b. Informally assess the fit of a function by plotting and analyzing residuals, including with the use of technology.

Career Readiness, Life Literacies, and Key Skills:

- 9.4.12.CI.1** Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
- 9.4.12.CT.1** Identify problem-solving strategies used in the development of an innovative product or practice.
- 9.4.12.CT.2** Explain the potential benefits of collaborating to enhance critical thinking and problem solving.
- 9.4.12.IML.2** Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.
- 9.4.12.TL.1** Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

Interdisciplinary Connections and Standards:

ELA

- RI.CR.11–12.1** Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text.
- L.SS.11–12.1** Demonstrate command of the system and structure of the English language when writing or speaking.
- L.VL.11–12.3** Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, including technical meanings, choosing flexibly from a range of strategies.
- W.AW.11–12.1** Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
- W.IW.11–12.2** Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
- W.WR.11–12.5** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- W.RW.11–12.7** Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes.
- SL.PE.11–12.1** Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
- SL.II.11–12.2** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
- SL.PI.11–12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.
- SL.AS.11–12.6** Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.

Science

- HS-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Unit Understandings:

Students will understand ...

- Extending the properties of exponents to rational exponents.
- Solving equations is a process of reasoning and explaining the reasoning.
- Solving radicals, exponential, and logarithmic equations and inequalities in one variable.

- Representing and solving radicals, exponential and logarithmic equations and inequalities graphically.
- Creating equations that describe numbers or relationships.
- Interpreting the structure of expressions.
- Writing expressions in equivalent forms to solve problems.
- Building radicals, exponential, and logarithmic function that models a relationship between two quantities.
- Building new functions from existing functions.
- The concept of a function and using function notation.
- Analyzing functions using different representations.
- Constructing and comparing linear and exponential models and solving problems.
- Interpreting expressions for functions in terms of the situation they model.

Unit Essential Questions:

- How can you use a rational exponent to represent a power involving a radical?
- How can you solve a radical equation?
- How can you identify and verify the inverse of a function?
- What are some of the characteristics of the graph of an exponential and logarithmic function?
- How can you transform the graphs of exponential and logarithmic functions?
- How can you solve exponential and logarithmic equations?
- How can you recognize polynomial, exponential, and logarithmic models?

Knowledge and Skills:

Students will know...

- Rational exponents and radical functions.
- Solving equations containing n th roots.
- How to describe and graph transformations of radical functions.
- How to solve equations and inequalities containing radicals and rational exponents.
- How to perform arithmetic operations (addition, subtraction, multiplication, division, and compositions) on two functions.
- The relationship between inverse functions.
- Exponential and logarithmic functions.
- Graphing and writing exponential decay, exponential growth, and logarithmic functions and describing their transformations.
- Properties of logarithms and how to use them.
- Solving exponential and logarithmic equations.
- Arithmetic and geometric sequences and series.
- How to find partial sums and sums of finite geometric series.
- Writing and utilizing recursively defined sequences.
- Vocabulary: n th roots, the simplest form of a radical, like radicals, radical expressions, radical functions, rational exponents, extraneous solutions, inverse functions, exponential growth & decay functions, growth factor, decay factor, the natural base e , logarithmic & exponential functions, sequence, arithmetic sequence, common difference, geometric sequence, common ratio, partial sum, explicit rule, and recursive rule.

Students will be able to...

- Represent roots using rational exponents.
- Describe the properties of rational exponents and radicals.
- Solve radical equations and inequalities.
- Find compositions and inverses of functions.
- Solve equations using n th roots.

- Simplify variable expressions containing rational exponents and radicals.
- Write functions that represent transformations of radical functions.
- Solve real-life problems involving radical equations.
- Discover arithmetic combinations for two functions.
- Evaluate an arithmetic combination of two functions for a given input.
- Appraise a composition of functions.
- Justify whether a pair of functions are inverses.
- Determine whether a function represents exponential growth or decay.
- Simplify exponential and logarithmic expressions.
- Solve exponential and logarithmic equations.
- Model exponential and logarithmic functions.
- Solve real-life problems using exponential growth and decay functions.
- Simplify natural base e expressions.
- Evaluate logarithmic expressions and graph logarithmic functions.
- Write functions that represent transformations of exponential and logarithmic functions.
- Evaluate the properties of logarithms.
- Solve exponential and logarithmic inequalities.
- Utilize technology to find exponential models and logarithmic models for sets of data.
- Define and use sequences and series.
- Describe how to find sums of infinite geometric series.
- Analyze arithmetic and geometric sequences and series.
- Explain how to write recursive rules for sequences.
- Produce rules for arithmetic sequences and geometric sequences.
- Solve real-life problems using sums and partial sums of infinite geometric sequences.
- Compare and contrast the explicit rules and recursive rules of sequences.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly “understand”?

- End of Unit Common Assessment - See folder for assessment links.
- Formative: warm-up activities, exploratory activities, class discussions, student participation, homework, and exit tickets.
- Summative: quizzes, tests, projects, and benchmark assessments.
- Open-ended problems that involve written responses with justification of answers.
- Renaissance Star Math Diagnostic Assessment – Fall, Winter, Spring

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Interactive Platforms: Desmos, Kahoot, Delta Math, Formative, Quizizz, Quizlet, Google Forms, Mathspace, PearDeck, Freckle, Geogebra, Gimkit, and Khan Academy.
- Group Work Suggestion: quiz trade, circuits, limit war, matching card games, jeopardy, relay review, and speed dating.
- **Sample Application Activities:**
 - Students apply their understanding of the properties of rational exponents to compare and contrast frequencies of sound waves produced by different octaves on a piano.

- Students apply their understanding of exponential decay models and solving exponential equations to use information about an ancient manuscript written on papyrus to approximate the number of years since the papyrus plant died.
- Students apply their understanding of sequences to determine whether the Department of Natural Resources will meet its goal to stabilize a walleye population in a lake in Minnesota.

RESOURCES

Teacher Resources:

- **Textbook:** Larson, R. and Boswell, L. (2022). Algebra 2. Erie, PA: Big Ideas Learning, LLC.
- Useful Websites for Teachers to Utilize:
 - www.illustrativemathematics.org
 - <http://www.ixl.com>
 - www.kutasoftware.com
 - <https://www.khanacademy.org/>
 - <https://learnzillion.com/>
 - <https://www.teachingchannel.org/>
 - <http://illuminations.nctm.org>

Equipment Needed:

- Projector, Computer/Laptop, Chromebooks, Document Camera, Graphing Calculator

UNIT 4 OVERVIEW

Content Area: Mathematics

Unit Title: Rational Functions; Probability, Statistics & Data Analysis;
Trigonometry & Unit Circle (Honors Only)

Target Course/Grade Level: Algebra II & Algebra II Honors/Grades 9-12

Unit Summary: This unit extends students' knowledge of functions to rational functions. Students will study the behavior, graphs, and real-life applications of rational functions. This unit will also focus on the ability to understand independent probability and conditional probability, use them to interpret data and use probability rules to find probabilities of compound events. As well as to understand and evaluate processes underlying statistical experiments, and to make inferences and justify conclusions from sample surveys, experiments, and observational studies.

(Honors Only) This final part of the unit will extend students' knowledge of functions to trigonometric functions. Students will evaluate and graph trigonometric functions, model using trigonometric functions, and use trigonometric identities.

Approximate Length of Unit: 8 weeks

LEARNING TARGETS

NJ Student Learning Standards:

- F.BF.B.3** Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.
- A.CED.A.1** Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
- A.CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- A.APR.C.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.
- A.APR.D.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.D.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.A.2** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
- S.CP.A.1** Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").

- S.CP.A.2** Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
- S.CP.A.3** Understand the conditional probability of A given B as $P(A \text{ and } B)/P(B)$, and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.
- S.CP.A.4** Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.
- S.CP.A.5** Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.
- S.CP.B.6** Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.
- S.CP.B.7** Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, and interpret the answer in terms of the model.
- S.CP.B.8** Apply the general Multiplication Rule in a uniform probability model, $P(A \text{ and } B) = P(A)P(B|A) = P(B)P(A|B)$, and interpret the answer in terms of the model.
- S.CP.B.9** Use permutations and combinations to compute probabilities of compound events and solve problems.
- S.IC.A.1** Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
- S.IC.A.2** Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?
- S.IC.B.3** Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
- S.IC.B.4** Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.
- S.IC.B.5** Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
- S.IC.B.6** Evaluate reports based on data (e.g. interrogate study design, data sources, randomization, the way the data are analyzed and displayed, inferences drawn and methods used; identify and explain misleading uses of data; recognize when arguments based on data are flawed).

Honors Only:

- F.IF.C.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.
- F.TF.A.1** Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.
- F.TF.A.2** Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.
- F.TF.B.5** Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.
- F.TF.C.8** Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.
- F.TF.C.9** Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Career Readiness, Life Literacies, and Key Skills:

9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.CT.1 Identify problem-solving strategies used in the development of an innovative product or practice.

9.4.12.CT.2 Explain the potential benefits of collaborating to enhance critical thinking and problem solving.

9.4.12.IML.2 Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.TL.1 Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task.

Interdisciplinary Connections and Standards:

ELA

RI.CR.11–12.1 Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text.

L.SS.11–12.1 Demonstrate command of the system and structure of the English language when writing or speaking.

L.VL.11–12.3 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, including technical meanings, choosing flexibly from a range of strategies.

W.AW.11–12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

W.IW.11–12.2 Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

W.WR.11–12.5 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

W.RW.11–12.7 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes.

SL.PE.11–12.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

SL.II.11–12.2 Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SL.PI.11–12.4 Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.

SL.AS.11–12.6 Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.

Science

HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Unit Understandings:

Students will understand ...

- Creating equations that describe numbers or relationships.
- Utilizing polynomial identities to solve problems.
- Rewriting rational expressions.
- Solving equations as a process of reasoning and explaining the reasoning.
- Building new functions from existing functions.
- Independence and conditional probability and use them to interpret data.

- The rules of probability to compute probabilities of compound events in a uniform probability model.
- Evaluating random processes underlying statistical experiments.
- Making inferences and justifying conclusions from sample surveys, experiments, and observational studies.

Honors Only:

- Extending the domain of trigonometric functions using the unit circle.
- Modeling periodic phenomena with trigonometric functions.
- Proving and applying trigonometric identities.

Unit Essential Questions:

- What are some of the characteristics of the graph of a rational function?
- How can you determine the domain (including any excluded values) in any operations of two rational expressions?
- How can you solve a rational equation?
- How can you determine whether two events are independent or dependent?
- How can you find the permutations or combinations of events?
- In a normal distribution, about what percent of the data lies within one, two, and three standard deviations of the mean?
- How can you test theoretical probability using sample data?
- What are some considerations when undertaking a statistical study?

Honors Only:

- How can you find a trigonometric function of an acute angle θ ?
- How can you find the measure of an angle in radians?
- How can you use the unit circle to define the trigonometric functions of any angle?
- What are the characteristics of the graphs of the sine, cosine, and tangent functions?
- How can you verify a trigonometric identity?

Knowledge and Skills:

Students will know...

- Describing and graphing rational functions.
- Performing operations (addition, subtraction, multiplication, and division) on rational expressions.
- Solving rational equations.
- Sample spaces and probabilities of events.
- How to use two-way tables to represent data and find probabilities.
- Independent and dependent events and their probabilities.
- Overlapping and disjoint events and their probabilities.
- How to count permutations and combinations.
- Normal distributions.
- Sampling methods and how to use random sampling and simulations to make conclusions.
- How to make inferences from experiments.
- Vocabulary: rational functions, complex fractions, conditional probability, two-way tables, independent and dependent events, and permutations and combinations.

Honors Only:

- The six trigonometric functions (sine, cosine, tangent, cosecant, secant, and cotangent).
- Radian measures of angles.
- Describing sine, cosine, and tangent functions graphically.
- Writing trigonometric functions and using their identities to evaluate and simplify trigonometric expressions.
- Vocabulary: radians, unit circle, sine, cosine, and tangent functions, and trig identities.

Students will be able to...

- Determine whether an equation represents direct variation or inverse variation.
- Graph rational functions.
- Add, subtract, multiply, and divide rational expressions.
- Solve rational equations.
- Solve real-life problems using inverse variation functions.
- Assess how to find the asymptotes of a rational function from an equation.
- Add, subtract, multiply, and divide rational functions.
- Justify how to find a common denominator for rational expressions.
- Solve real-life problems using inverses and rational functions.
- Define theoretical and experimental probability.
- Use two-way tables to find probabilities.
- Compare independent and dependent events.
- Construct and interpret probability and binomial distributions.
- Discover theoretical and experimental probabilities.
- Find and utilize conditional relative frequencies to find probabilities.
- Compare events to determine if they are dependent or independent.
- Solve real-life problems using more than one probability rule.
- Discover probabilities using permutations and combinations.
- Construct and interpret probability distributions.
- Find probabilities in normal distributions.
- Identify populations and samples.
- Explain different methods for collecting data.
- Make inferences from sample surveys and experiments
- Distinguish between populations and samples.
- Analyze varying methods of collecting data.
- Design an experiment or observational study.
- Utilize resampling to make inferences about experiments.

Honors Only:

- Define right triangle trigonometric functions.
- Evaluate trigonometric functions of any angle.
- Graph trigonometric functions.
- Model using trigonometric functions.
- Utilize trigonometric functions to find side lengths of right triangles.
- Convert between degrees and radians.
- Assess the arc length and area of a sector using radian measure.
- Solve real-life problems involving projectiles.
- Graph transformations of sine and cosine functions.
- Discover a trigonometric model for a set of data using technology.
- Evaluate trigonometric functions using trigonometric identities.
- Solve trigonometric equations using sum and difference formulas.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly “understand”?

- End of Unit Common Assessment - See folder for assessment links.
- Formative: warm-up activities, exploratory activities, class discussions, student participation, homework, and exit tickets.
- Summative: quizzes, tests, projects, and benchmark assessments.
- Open-ended problems that involve written responses with justification of answers.
- Renaissance Star Math Diagnostic Assessment – Fall, Winter, Spring

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Interactive Platforms: Desmos, Kahoot, Delta Math, Formative, Quizizz, Quizlet, Google Forms, Mathspace, PearDeck, Freckle, Geogebra, Gimkit, and Khan Academy.
- Group Work Suggestion: quiz trade, circuits, limit war, matching card games, jeopardy, relay review, and speed dating.
- **Sample Application Activities:**
 - Students design a 3-D project and apply their understanding of writing and graphing functions, including rational functions, to describe several relationships as the number of copies increases.
 - Students apply their understanding of probability to choose an excavation site that is likely to contain a significant number of ancient artifacts.
 - Students apply their understanding of normal distributions to write a report about worldwide volcanic activity.
 - **Honors Only:** Students apply their understanding of right triangles and trigonometric ratios to determine the time it will take to sail a boat to a port.

RESOURCES

Teacher Resources:

- **Textbook:** Larson, R. and Boswell, L. (2022). Algebra 2. Erie, PA: Big Ideas Learning, LLC.
- Useful Websites for Teachers to Utilize:
 - www.illustrativemathematics.org
 - <http://www.ixl.com>
 - www.kutasoftware.com
 - <https://www.khanacademy.org/>
 - <https://learnzillion.com/>
 - <https://www.teachingchannel.org/>
 - <http://illuminations.nctm.org>

Equipment Needed:

- Projector, Computer/Laptop, Chromebooks, Document Camera, Graphing Calculator