

Mathematics Curriculum Guide

Grades 9-12 Mathematics Writing Committee

All high school mathematics teachers participated in the high school mathematics curriculum revision process, thereby affording opportunities for teachers to add their knowledge and professional experiences to the process. Teachers on the mathematics writing committee based the curriculum on teacher input and recommendations collected from collaboration efforts. The curriculum writing committee members will act as a resource to their department colleagues. Opportunities to discuss the curriculum implementation, teaching strategies, resources, as well as reflections and concerns will be provided during the 2011-12 school year.

I am grateful to the mathematics curriculum committee members for the many hours and expertise they devoted to writing this curriculum guide. The committee members are commended for their efforts and interest in providing the Park Ridge School District with a thorough high school mathematics curriculum that aligns with the Common Core State Standards for Mathematics.

According to the 2010 Common Core State Standards Initiative, “The Common Core State Mathematical Standards are designed to provide a clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers.”

Dr. Cathy Timpone
Director of Curriculum & Instruction

Mathematics Curriculum Guide

High School Mathematics Curriculum Writing Committee:

Lynne Lupfer revised:

Mathematics Prep, Geometry Honors, Algebra II Honors,
Pre-Calculus, Pre-Calculus Honors, SAT Prep Math curriculum guides

Rachel Berger revised:

Pre-Algebra, Algebra II, Algebra II Honors curriculum guides

Erin Havel revised:

Algebra I, Algebra I Honors curriculum guides

Roseanne Wates revised:

Geometry, Statistics curriculum guides

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Statistics curriculum guide

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Life Skills Math curriculum guide

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Life Skills Math curriculum guides

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Board Approved August 27, 2012

PARK RIDGE SCHOOL DISTRICT
Park Ridge, NJ

MATHEMATICS DEPARTMENT, 2011-2012

COURSE TITLE/GRADE & SUBJECT: Precalculus

COURSE # 2530

PREREQUISITE: Algebra 2

TIME ALLOCATION: Full Year

TEXTS: *Precalculus With Limits: A Graphing Approach*

Larson, Hostetler, Edwards, Houghton Mifflin, 2005

Trigonometry

Dugopolski, Pearson 2007

COURSE PHILOSOPHY (grades 7-12): This course will prepare students with the skills and theory that are the foundations of calculus.

OVERARCHING ENDURING UNDERSTANDINGS (grade 7-12):

- Trigonometry can be used to determine indirect measurements of lengths and angles to solve a variety of problems.
- Mathematical functions can be used to solve real world applications.
- Various graphical and algebraic methods can be used to analyze and solve systems of linear and quadratic equations.
- Conic sections can be identified and graphed from their equations.
- Exponential and logarithmic functions are inverse functions.
- More advanced concepts of probability can be used to solve real-world problems.
- Data sets can be analyzed to form hypotheses and make predictions using different types of regression models
- Arithmetic and geometric sequences and series are mathematical patterns that stem from practical situations.

OVERARCHING ESSENTIAL QUESTIONS (grades 7-12):

- What is the relationship between right-triangle trigonometry and circular trigonometry and how can each be applied to solve real-world problems?
- How can graphs and equations of functions and their inverses help us to interpret real world problems?
- What are the characteristics of the conic sections and how do they apply to real-world problems?
- How can analytic and graphical methods be used to support each other in the solution of a problem?
- How can probability be applied in a real-world situation?
- How can the curve of best fit help predict trends of data?

- How can graphs and equations of functions help us to interpret real-world problems?
- How can analytic and graphical methods be used to support each other in the solution of a problem?
- What is the difference between series and sequences?

TABLE OF CONTENTS (UNITS OF STUDY):

Unit 1 Angular Measure

Unit 2 Graphing Trigonometric Functions

Unit 3 Verifying Trigonometric Identities

Unit 4 Solving Trigonometric Equations

Unit 5 Solving Triangles and Finding Area

Unit 6 Polynomial Functions

Unit 7 Logarithmic and Exponential Functions

Unit 8 Conic Sections

Unit 9 Sequence and Series

Unit 10 Probability

UNIT ONE: ANGULAR MEASURE

UNIT SUMMARY:

1. The students will be able to measure angles in degrees and radians.
2. The students will evaluate all six trigonometric functions using the unit circle.
3. This unit introduces the concept of a radian and the cofunctions after reviewing sin, cos and tan.
4. Students will develop a foundation for the study of trigonometry.

21ST CENTURY THEMES:

- Global Awareness
- Financial, Economic, Business and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy

PRIMARY INTERDISCIPLINARY CONNECTIONS:

This unit prepares the student for STEM course work: physics, engineering and design, construction, landscaping.

STANDARDS

- F-IF1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x . The graph of f is the graph of the equation $y = f(x)$.
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
- F-TF1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.
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.
3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi-x$, $\pi+x$, and $2\pi-x$ in terms of their values for x , where x is any real number.
4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.
- 9.1.12.A.1 Apply critical thinking and problem-solving strategies during structured learning experiences.
- 9.1.12.B.1 Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.
- 9.1.12.C.5 Assume a leadership position by guiding the thinking of peers in a direction that leads to successful completion of a challenging task or project.
- 9.1.12.F.2 Demonstrate a positive work ethic in various settings, including the classroom and during structured learning experiences.
- RST.11.3-7
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

<p>UNIT ESSENTIAL QUESTIONS: What is the relationship between degree measure and radians? How do we use angles to calculate velocity? How do we use the six trig functions?</p>	<p>UNIT ENDURING UNDERSTANDINGS:</p> <ul style="list-style-type: none"> ▪ Angles can be measured in degrees and radians ▪ Angles can be used to calculate velocity ▪ Trig functions can be used to solve right triangles.
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TIME ALLOTMENT	CONTENT	SKILLS	ASSESSMENT
15 days	Degree Radian Coterminal angles Sin Cos Tan Csc Sec Cot Reference angle Angular velocity Linear velocity SOHCAHTOA Unit Circle	<ul style="list-style-type: none"> ▪ Convert radians to degrees ▪ Convert degrees to radians ▪ Find coterminal and reference angles ▪ Find linear and angular velocity ▪ Evaluate the six trig functions around the unit circle 	Tests Quizzes <i>Pi Guys</i> project Student presentations Exit slips

<p>TEACHER RESOURCES Textbook <i>Algebra in Motion</i> software Graphing calculators</p>	<p>TEACHER NOTES/REFLECTIONS</p>
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UNIT TWO: GRAPHING TRIGONOMETRIC FUNCTIONS

UNIT SUMMARY:

1. Students will be able to unwrap the unit circle to graph trig functions.
2. Student will be able to translate the graphs using phase shifts, vertical shifts, amplitude change and period change.
3. Once we can calculate trig values, we need to graph the functions.
4. Graphing the trig functions demonstrates the periodic nature of the functions.

<p>21ST CENTURY THEMES:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Global Awareness <input checked="" type="checkbox"/> Financial, Economic, Business and Entrepreneurial Literacy <input type="checkbox"/> Civic Literacy <input type="checkbox"/> Health Literacy 	<p>PRIMARY INTERDISCIPLINARY CONNECTIONS:</p> <p>This unit prepares the student for STEM course work; mechanical engineering, graphing, landscaping, computer applications.</p>
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STANDARDS

F-TF 5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. ★

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

e. Graph trigonometric functions, showing period, midline, and amplitude.

9.1.12.A.1 Apply critical thinking and problem-solving strategies during structured learning experiences.

9.1.12.B.1 Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.

9.1.12.C.5 Assume a leadership position by guiding the thinking of peers in a direction that leads to successful completion of a challenging task or project.

9.1.12.F.2 Demonstrate a positive work ethic in various settings, including the classroom and during structured learning experiences.

RST.11.3-7

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

UNIT ESSENTIAL QUESTIONS:

- How do we derive the graphs of Trig functions from the Unit circle?
- How do we transform the graphs of trig functions?

UNIT ENDURING UNDERSTANDINGS:

- Trig functions can be unwrapped from the unit circle.
- The graphs of trig functions can be translated, reflected and dilated.

TIME ALLOTMENT	CONTENT	SKILLS	ASSESSMENT
20 days	Amplitude Phase Shift Period Vertical translation Frequency Domain & Range Asymptotes Critical Points	<ul style="list-style-type: none"> • determine the period and amplitude of all trig functions • graph all trig functions of varying periods and amplitudes • perform transformations on all trig functions (e.g., translations, reflections, dilations) 	Tests Quizzes <i>Unwrap the Circle</i> project Student presentations Exit Slips

TEACHER RESOURCES

Textbook
Algebra in Motion software
Green Globes software
 Graphing calculators
 Graph paper

TEACHER NOTES/REFLECTIONS

UNIT THREE: VERIFYING TRIGONOMETRIC IDENTITIES

UNIT SUMMARY:

- We can express trig functions in many different ways.
- We can prove that different trig functions may be equivalent.
- Students must be able to use equivalent expressions to evaluate trig functions in Calculus.

21ST CENTURY THEMES:

- Global Awareness
- Financial, Economic, Business and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy

PRIMARY INTERDISCIPLINARY CONNECTIONS:

This unit prepares the student for STEM course work.

STANDARDS

- F-IF 8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
- F-TF 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.
9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.
- 9.1.12.A.1 Apply critical thinking and problem-solving strategies during structured learning experiences.
- 9.1.12.B.1 Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.
- 9.1.12.C.5 Assume a leadership position by guiding the thinking of peers in a direction that leads to successful completion of a challenging task or project.
- 9.1.12.F.2 Demonstrate a positive work ethic in various settings, including the classroom and during structured learning experiences.
- RST.11.3-7
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

<p>UNIT ESSENTIAL QUESTIONS: How can we express the same trig function in different ways? How can we determine if these different expressions are equivalent?</p>	<p>UNIT ENDURING UNDERSTANDINGS:</p> <ul style="list-style-type: none"> ▪ Trig functions can be expressed in many ways. ▪ We can use identities to prove that expressions are equivalent.
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TIME ALLOTMENT	CONTENT	SKILLS	ASSESSMENT
20 days	Even & odd functions Cofunctions Pythagorean Identities Reciprocal Identities Sum and Difference Formulas Double and Half angle Formulas	<ul style="list-style-type: none"> ▪ Simplify trig expressions ▪ Factoring trig expressions ▪ Apply all formulas ▪ Verify trig identities 	Tests Quizzes Exit Slips

<p>TEACHER RESOURCES Textbook <i>Geometers Sketchpad</i></p>	<p>TEACHER NOTES/REFLECTIONS</p>
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UNIT FOUR: SOLVING TRIGONOMETRIC EQUATIONS

UNIT SUMMARY:

- Students will be able to solve equations involving trigonometric functions.
- Students will use identities to simplify expressions to evaluate functions.
- Students will use inverse functions to solve equations.
- This unit logically follows the unit on identities.
- Students must be able to solve trig equations in order to achieve success in Calculus.

21ST CENTURY THEMES:

- Global Awareness
- Financial, Economic, Business and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy

PRIMARY INTERDISCIPLINARY CONNECTIONS:

This unit prepares the student for STEM course work; mechanical engineering, landscape design, physics.

STANDARDS

- F-TF 6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.
7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. ★
- 9.1.12.A.1 Apply critical thinking and problem-solving strategies during structured learning experiences.
- 9.1.12.B.1 Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.
- 9.1.12.C.5 Assume a leadership position by guiding the thinking of peers in a direction that leads to successful completion of a challenging task or project.
- 9.1.12.F.2 Demonstrate a positive work ethic in various settings, including the classroom and during structured learning experiences.
- RST.11.3-7
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

<p>UNIT ESSENTIAL QUESTIONS: How does a function relate to its inverse? How do we use the inverse of a function to solve an equation?</p>	<p>UNIT ENDURING UNDERSTANDINGS:</p> <ul style="list-style-type: none"> ▪ Inverse functions can be used to solve equations
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TIME ALLOTMENT	CONTENT	SKILLS	ASSESSMENT
15 days	Inverse Domain & Range Extraneous solutions	<ul style="list-style-type: none"> • solve trigonometric equations on a specified interval <ul style="list-style-type: none"> ▪ Solve trigonometric equations • recognize multiple solutions to problems occurring over predetermined intervals 	Tests Quizzes Exit Slips

<p>TEACHER RESOURCES</p> <ul style="list-style-type: none"> ▪ Textbook ▪ Graphing calculator ▪ <i>Geometers Sketchpad</i> 	<p>TEACHER NOTES/REFLECTIONS</p>
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UNIT FIVE: SOLVING TRIANGLES AND FINDING AREA

UNIT SUMMARY:

- Students will be able to find missing measures in triangles.
- Students will be able to find the area of any triangle.
- This unit reviews material taught in Geometry and expands the Law of Sines to include the oblique case.

21ST CENTURY THEMES:

- Global Awareness
- Financial, Economic, Business and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy

PRIMARY INTERDISCIPLINARY CONNECTIONS:

This unit prepares the student for STEM course work; landscape design, mechanical engineering.

STANDARDS

- G-SRT9. (+) Derive the formula $A = 1/2 ab \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.
10. (+) Prove the Laws of Sines and Cosines and use them to solve problems.
11. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).
- 9.1.12.A.1 Apply critical thinking and problem-solving strategies during structured learning experiences.
- 9.1.12.B.1 Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.
- 9.1.12.C.5 Assume a leadership position by guiding the thinking of peers in a direction that leads to successful completion of a challenging task or project.
- 9.1.12.F.2 Demonstrate a positive work ethic in various settings, including the classroom and during structured learning experiences.
- RST.11.3-7

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

UNIT ESSENTIAL QUESTIONS:

How do we solve a triangle?
How do we find the area of any triangle?

UNIT ENDURING UNDERSTANDINGS:

- All triangles can be solved using trigonometry
- Trigonometry can be used to find the area of any triangle.

TIME ALLOTMENT	CONTENT	SKILLS	ASSESSMENT
Identify by Month, Weeks or Days	Law of Sines Law of Cosines Ambiguous Case Area Heron's Formula	<ul style="list-style-type: none"> ▪ Identify when to use law of sines and law of cosines ▪ Identify ambiguous case when presented Identify different methods to find area	Tests Quizzes Student Presentations of homework problems Exit Slips

TEACHER RESOURCES

Textbook
Algebra in Motion software
Geometers Sketchpad software

TEACHER NOTES/REFLECTIONS

UNIT SIX: Polynomial Functions

UNIT SUMMARY:

As an overview:

1. Students will be able to identify the roots, extrema and end behavior of polynomial functions.
2. This unit is a review of and expansion on Algebra 2 concepts.
3. Concepts taught in this unit will serve as a foundation for Calculus.

21ST CENTURY THEMES:

- Global Awareness
- Financial, Economic, Business and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy

PRIMARY INTERDISCIPLINARY CONNECTIONS:

1. This unit prepares the student for STEM course work.

STANDARDS

- F-IF 1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x . The graph of f is the graph of the equation $y = f(x)$.
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
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.**
5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
- a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
- c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
- F-BF 1. Write a function that describes a relationship between two quantities.*
- a. Determine an explicit expression, a recursive process, or steps for calculation from a context.
- b. Combine standard function types using arithmetic operations.
- c. (+) Compose functions.
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.*
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.

b. (+) Verify by composition that one function is the inverse of another.

c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.

9.1.12.A.1 Apply critical thinking and problem-solving strategies during structured learning experiences.

9.1.12.B.1 Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.

9.1.12.C.5 Assume a leadership position by guiding the thinking of peers in a direction that leads to successful completion of a challenging task or project.

9.1.12.F.2 Demonstrate a positive work ethic in various settings, including the classroom and during structured learning experiences.

RST.11.3-7

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

UNIT ESSENTIAL QUESTIONS:

- How many solutions can exist? Explain.
- Do we care about all of the solutions? Why or why not?
- How can more than one model be possible for a given real world situation?
- What is the relationship between the graph of a function and its algebraic rule?

UNIT ENDURING UNDERSTANDINGS:

- A rule can be found to identify every function.
- Some models have real solutions, while others will not
- Some models may have multiple solutions, but some of these may not be appropriate
- The graph of a function can provide significant insights into the nature of solutions for the function
- We can “model” real-world situations

TIME ALLOTMENT	CONTENT	SKILLS	ASSESSMENT
30 days	Domain Range Inverse Intercepts Roots Maximum/Minimum values Symmetry Degree Root Zeroes of a function Odd function/Even function Increasing/decreasing functions Descartes Rule of Signs	<ul style="list-style-type: none"> • Determine the number of possible real and complex roots • Find all possible roots of a function • Graph a polynomial function general properties and behavior of functions of one variable using appropriate graphing techniques: <ul style="list-style-type: none"> ▪ identify domain and range ▪ identify intercepts ▪ solve to find the roots of equations ▪ identify maximum and minimum points ▪ find points that lie on the graph of a function ▪ compare the properties of different classes of functions, 	Tests Quizzes Exit Slips Student Presentations <i>BirthDay Polynomial</i> project (advanced version)

		<ul style="list-style-type: none">including symmetryperform operations on functions, including composite functions	
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TEACHER RESOURCES <ul style="list-style-type: none">TextbookGraphing CalculatorSMARTboard<i>Algebra in Motion</i> software<i>Geometer's Sketchpad</i> software	TEACHER NOTES/REFLECTIONS
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UNIT SEVEN: LOGARITHMIC AND EXPONENTIAL FUNCTIONS

UNIT SUMMARY:

As an overview:

- Students will use logarithmic and exponential functions to model real world data.
- This unit is an expansion of the material taught in Algebra 2.
- Students will apply this knowledge in their science courses.

21ST CENTURY THEMES:

- Global Awareness
- Financial, Economic, Business and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy

PRIMARY INTERDISCIPLINARY CONNECTIONS:

This unit prepares the student for STEM course work; physics, chemistry and engineering.

STANDARDS

N-Q1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

2. Define appropriate quantities for the purpose of descriptive modeling.

3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

F-IF 4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.

5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

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.

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 $y = (1.02)_t$, $y = (0.97)_t$, $y = (1.01)_{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth or decay.*

F-BF1. Write a function that describes a relationship between two quantities.*

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.

4. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

F-LE1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

- a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.
 - b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
 - c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
 3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
 4. 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.
 5. Interpret the parameters in a linear or exponential function in terms of a context.
- S-ID 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; use functions fitted to data to solve problems in the context of the data. *Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.*
 - b. Informally assess the fit of a function by plotting and analyzing residuals.
- 9.1.12.A.1 Apply critical thinking and problem-solving strategies during structured learning experiences.
 - 9.1.12.B.1 Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.
 - 9.1.12.C.5 Assume a leadership position by guiding the thinking of peers in a direction that leads to successful completion of a challenging task or project.
 - 9.1.12.F.2 Demonstrate a positive work ethic in various settings, including the classroom and during structured learning experiences.
- RST.11.3-7
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
 4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
 5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
 6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
 7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

UNIT ESSENTIAL QUESTIONS:

- What happens when a population grows or decays in an unrestricted fashion?
- How do you solve a problem when the variable appears in the exponent?
- What is the relationship between exponential functions and logarithms?

UNIT ENDURING UNDERSTANDINGS:

- the algebraic functions (those with rational exponents) are expanded and enhanced by the transcendental functions (those with variable exponents)
- inverse functions provide a key problem-solving tool since they “undo” transformations

TIME ALLOTMENT	CONTENT	SKILLS	ASSESSMENT
20 days	Base Exponent Inverse function Domain Range Asymptotes Growth/Decay Compound Interest	<ul style="list-style-type: none"> ▪ simplify and evaluate using the properties of logarithms ▪ solve exponential and logarithmic equations ▪ calculate compound interest and compare interest compounded over time and continually ▪ model growth and decay functions 	<ul style="list-style-type: none"> ▪ tests ▪ quizzes ▪ <i>Logarithm Webquest</i> ▪ Student presentations of projects ▪ Exit slips

		▪ graph exponential and logarithmic functions	
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TEACHER RESOURCES	TEACHER NOTES/REFLECTIONS
<ul style="list-style-type: none">▪ Textbook▪ Graphing calculator▪ SMARTboard▪ <i>Geometers' Sketchpad</i>▪ Internet	

UNIT EIGHT: CONIC SECTIONS

UNIT SUMMARY:

- 1) There are important figures that are not functions found by slicing a cone at different angles.
- 2) This unit is presented after the conclusion of the function units.
- 3) Conic sections have properties that are used in real world situations.

21ST CENTURY THEMES:

- Global Awareness
- Financial, Economic, Business and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy

PRIMARY INTERDISCIPLINARY CONNECTIONS:

This unit prepares the student for STEM course work; space exploration, architecture.

STANDARDS

- N-Q1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
2. Define appropriate quantities for the purpose of descriptive modeling.
3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities
- F-BF 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.
- A-SSE 2. Use the structure of an expression to identify ways to rewrite it.
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.
- 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-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).
- G-GPE1. Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.
2. Derive the equation of a parabola given a focus and directrix.
3. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.
- 9.1.12.A.1 Apply critical thinking and problem-solving strategies during structured learning experiences.
- 9.1.12.B.1 Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.
- 9.1.12.C.5 Assume a leadership position by guiding the thinking of peers in a direction that leads to successful completion of a challenging task or project.
- 9.1.12.F.2 Demonstrate a positive work ethic in various settings, including the classroom and during structured learning experiences.
- RST.11.3-7
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

<p>UNIT ESSENTIAL QUESTIONS:</p> <ul style="list-style-type: none"> ▪ What are the different graphs of equations that are not functions? ▪ How do we graph equations that are not functions? 	<p>UNIT ENDURING UNDERSTANDINGS:</p> <p>Different slices of a cone at different angles create different figures that are not functions</p>
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TIME ALLOTMENT	CONTENT	SKILLS	ASSESSMENT
20 days	Circle Ellipse Parabola Hyperbola Center Radius Focus Major axis Minor axis Directrix Eccentricity Asymptotes Latus rectum Translations	<ul style="list-style-type: none"> ▪ Graph all conic sections using critical information ▪ Write the equation of the conic section given the graph ▪ Translate graphs off of the origin 	<ul style="list-style-type: none"> ▪ Tests ▪ Quizzes ▪ <i>Conic Section Art Project</i> ▪ Student Presentations of projects ▪ Exit Slips

<p>TEACHER RESOURCES</p> <p>Textbook <i>Algebra in Motion</i> software Geometers' Sketchpad Graph paper <i>Green Globes</i> software</p>	<p>TEACHER NOTES/REFLECTIONS</p>

UNIT NINE: SEQUENCE AND SERIES

UNIT SUMMARY:

- 1) We can represent sequences and series using iterative and recursive formulas
- 2) This unit serves as an introduction to the study of series which is a foundation for Calculus.
- 3) Students will understand the concepts of finite and infinite series.

21ST CENTURY THEMES:

- Global Awareness
- Financial, Economic, Business and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy

PRIMARY INTERDISCIPLINARY CONNECTIONS:

This unit prepares the student for STEM course work; computer applications, business applications.

STANDARDS

F-IF.3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. *For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.*

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

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

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-LE.2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

9.1.12.A.1 Apply critical thinking and problem-solving strategies during structured learning experiences.

9.1.12.B.1 Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.

9.1.12.C.5 Assume a leadership position by guiding the thinking of peers in a direction that leads to successful completion of a challenging task or project.

9.1.12.F.2 Demonstrate a positive work ethic in various settings, including the classroom and during structured learning experiences.

RST.11.3-7

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

UNIT ESSENTIAL QUESTIONS:
How are sequences and series represented by algebraic formulas?

UNIT ENDURING UNDERSTANDINGS:

- Sequence and series are defined by iterative and recursive formulas

TIME ALLOTMENT	CONTENT	SKILLS	ASSESSMENT
15 days	Arithmetic Geometric Infinite Finite Recursive Sequence Series Nth term Sigma notation	<ul style="list-style-type: none"> ▪ recognize arithmetic and geometric sequences and series ▪ determine explicit formulas for the n^{th} term ▪ find terms of recursive sequences ▪ determine recursive sequence formulas ▪ find the sums of finite arithmetic and geometric series ▪ estimate the limit of an infinite geometric sequence ▪ Use sigma notation to represent arithmetic series 	Tests Quizzes Exit Slips

TEACHER RESOURCES

- Textbook
- Graphing calculator

TEACHER NOTES/REFLECTIONS

UNIT TEN: PROBABILITY

UNIT SUMMARY:

- 1) Students will learn to calculate the likelihood of an event or events occurring.
- 2) This unit may be taught last as it is a review unit. It will also serve as a foundation for those students moving onto Statistics.
- 3) Students will learn to use probability to evaluate outcomes of decisions

21ST CENTURY THEMES:

- Global Awareness
- Financial, Economic, Business and Entrepreneurial Literacy
- Civic Literacy
- Health Literacy

PRIMARY INTERDISCIPLINARY CONNECTIONS:

Probability theory is applied in all disciplines including the sciences, social sciences, health fields, business and economics.

STANDARDS

S-CP1. 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”).

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.
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 .
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.*
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.*
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.
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.
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.
9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

S-MD1. (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.

5. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.
3. (+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. *For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.*

4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. *For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?*
5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.
- a. Find the expected payoff for a game of chance. *For example, find the expected winnings from a state lottery ticket or a game at a fast food restaurant.*
- b. Evaluate and compare strategies on the basis of expected values. *For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.*
6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).
7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).
- 9.1.12.A.1 Apply critical thinking and problem-solving strategies during structured learning experiences.
- 9.1.12.B.1 Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.
- 9.1.12.C.5 Assume a leadership position by guiding the thinking of peers in a direction that leads to successful completion of a challenging task or project.
- 9.1.12.F.2 Demonstrate a positive work ethic in various settings, including the classroom and during structured learning experiences.
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7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

UNIT ESSENTIAL QUESTIONS:

How do we use permutations and combinations to determine the number of possible outcomes?

What is the likelihood of an event occurring?

How do we use probability to evaluate decisions?

UNIT ENDURING UNDERSTANDINGS:

- Permutations and combination are use to calculate the number of possibilities depending on the importance of order.
- The likelihood of an event occurring is determined by the ratio of the desired result divided by the total outcomes
- We can evaluate decisions based on expected outcomes.

TIME ALLOTMENT	CONTENT	SKILLS	ASSESSMENT
10 days	Events Odds Outcomes Independent/Dependent Compound events Mutually exclusive and inclusive events Conditional probability	<ul style="list-style-type: none"> ▪ determine the constraints of probability ▪ differentiate between experimental and theoretical probabilities ▪ compare and contrast independent and dependent events ▪ evaluate the probability of compound events with/without replacement ▪ evaluate the importance of order in calculating outcomes 	<ul style="list-style-type: none"> ▪ Tests ▪ Quizzes ▪ <i>Price is Right</i> project ▪ Student presentations of project ▪ Exit slips

		<ul style="list-style-type: none">▪ determine the total number of possible outcomes of an event▪ using permutations and combinations to calculate probability	
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TEACHER RESOURCES Textbook SMARTboard Video of <i>The Price is Right</i>	TEACHER NOTES/REFLECTIONS
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