

CARLISLE AREA SCHOOL DISTRICT

Carlisle, PA 17013

**PRE-CALCULUS**

**GRADES 11 and 12**

Date of Board Approval: April 17, 2014

**CARLISLE AREA SCHOOL DISTRICT  
PLANNED INSTRUCTION COVER PAGE**

<b>TITLE OF COURSE:</b> Pre-Calculus	<b>SUBJECT:</b> Math	<b>GRADE LEVEL:</b> 11 – 12
<b>COURSE LENGTH:</b> School Year	<b>DURATION:</b> 50 minutes	<b>FREQUENCY:</b> Daily
<b>PREREQUISITES:</b> Algebra I, II and Geometry	<b>CREDIT:</b> 1	<b>LEVEL:</b> HS

**Course Description/Objectives:**

Pre-Calculus is a course that extends and builds upon topics covered in Algebra II as well as introducing students to trigonometric concepts. By the end of this course, students should be able to solve and graph polynomial, exponential, logarithmic and trigonometric functions. Students will also have an understanding of the unit circle, be able to apply trigonometric identities and solve real world problems using trigonometric relationships.

**Text:** *Pre-Calculus, 8<sup>th</sup> Edition*, Ron Larson

**Curriculum Writing Committee:** Robyn Wolfe and Jess Armstrong

## COURSE TIMELINE

### **Unit 1A: Graphing Functions**

4.5 weeks

- Functions
- Parent graphs
- Transformations
- Describing graphs
- Inverse functions

### **Unit 1B: Analyzing Functions Algebraically**

4.5 weeks

- Absolute value functions
- Quadratic functions
- Radical functions
- Rational functions
- Piecewise functions
- Operations with functions

### **Unit 2: Polynomial and Rational Functions**

4.5 weeks

- Describe graphs of polynomials
- Write equations of polynomials
- Divide polynomials
- Solve polynomial equations
- Rational functions

### **Unit 3: Exponential and Logarithmic Functions**

4.5 weeks

- Graphs of exponential functions
- Graphs of logarithmic functions
- Properties of exponents and logarithms
- Solving exponential and logarithmic equations

### **Unit 4A: Trigonometric Functions**

4.5 weeks

- Measuring angles
- Circular functions
- Triangle trigonometry

**Unit 4B: Graphs of Trigonometric Functions**

4.5 weeks

- Parent graphs of trigonometric functions
- Transformations of trigonometric functions
- Graphing inverse trigonometric functions

**Unit 5: Trigonometric Identities and Equations**

4.5 weeks

- Fundamental identities
- Verifying identities
- Solving trigonometric equations

**Unit 6: Conic Sections**

4.5 weeks

- Conic Sections
- Circles
- Ellipses
- Parabolas
- Hyperbolas

TOTAL: 36 weeks

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #1A:** Graphing Functions

**GRADE:** 11 – 12

## STANDARDS:

### PA Core Standards:

- CC.2.2.HS.C.1 • Use the concept and notation of functions to interpret and apply them in terms of their context.
- CC.2.2.HS.C.2 • Graph and analyze functions and use their properties to make connections between the different representations.
- CC.2.2.HS.C.3 • Write functions or sequences that model relationships between two quantities.
- CC.2.2.HS.C.4 • Interpret the effects transformations have on functions and find the inverses of functions.
- CC.2.2.HS.C.6 • Interpret functions in terms of the situations they model.
- CC.2.2.HS.D.7 • Create and graph equations or inequalities to describe numbers or relationships.
- CC.2.2.HS.D.10 • Represent, solve, and interpret equations/inequalities, and systems of equations/inequalities algebraically and graphically.

### The Standards of Mathematical Practices:

- 1 Make sense of problems and persevere in solving them.
- 2 Reason abstractly and quantitatively.
- 4 Model with mathematics.
- 5 Use appropriate tools strategically.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #1A:** Graphing Functions

**GRADE:** 11 – 12

## UNDERSTANDINGS

The graph of a function is a useful way of visualizing the relationship the function models, and manipulating a mathematical expression for a function can throw light on the function's properties.

## COMMON ASSESSMENTS/CULMINATING ACTIVITY

Hershey Park Project, Unit Test

### KNOW

- Distinguish between bounded intervals and unbounded intervals.
- Differentiate between relations and functions.
- Identify functions by their parent graphs.
- Distinguish between rigid and non-rigid transformations.
- Classify functions as even, odd, or neither based on symmetry.
- Identify one-to-one functions.

### DO

- Express the domain and range in interval notation.
- Apply the vertical and horizontal line tests.
- Use transformations to change the graph of a function.
- Find the zeros, extrema, and intervals of increasing, decreasing, and constant in the graph of a function.
- Describe the graph of a function in paragraph form.
- Sketch the inverse of a function given its graph.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #1B:** Analyzing Functions Algebraically

**GRADE:** 11 – 12

## STANDARDS:

### PA Core Standards:

- CC.2.2.HS.C.1 • Use the concept and notation of functions to interpret and apply them in terms of their context.
- CC.2.2.HS.C.2 • Graph and analyze functions and use their properties to make connections between the different representations.
- CC.2.2.HS.C.3 • Write functions or sequences that model relationships between two quantities.
- CC.2.2.HS.C.4 • Interpret the effects transformations have on functions and find the inverses of functions.
- CC.2.2.HS.C.6 • Interpret functions in terms of the situations they model.
- CC.2.1.HS.D.2 • Write expressions in equivalent forms to solve.
- CC.2.1.HS.D.3 • Extend the knowledge of arithmetic operations and apply to polynomials.
- CC.2.2.HS.D.7 • Create and graph equations or inequalities to describe numbers or relationships.
- CC.2.2.HS.D.8 • Apply inverse operations to solve equations or formulas for a given variable.
- CC.2.2.HS.D.9 • Use reasoning to solve equations and justify the solution method.
- CC.2.2.HS.D.10 • Represent, solve, and interpret equations/inequalities, and systems of equations/inequalities algebraically and graphically.
- CC.2.2.HS.F.7 • Apply concepts of complex numbers in polynomial identities and quadratic equations to solve problems.

### The Standards of Mathematical Practices:

- 1 Make sense of problems and persevere in solving them.
- 2 Reason abstractly and quantitatively.
- 4 Model with mathematics.
- 5 Use appropriate tools strategically.
- 8 Look for and express regularity in repeated reasoning.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #1B:** Analyzing Functions Algebraically

**GRADE:** 11 – 12

## UNDERSTANDINGS

The graph of a function is a useful way of visualizing the relationship the function models, and manipulating a mathematical expression for a function can throw light on the function's properties.

## COMMON ASSESSMENTS/CULMINATING ACTIVITY

Piecewise Functions Project, Unit Test

### KNOW

- Recognize when a radical is simplified.
- Determine when it is appropriate to solve a quadratic equation by factoring vs. the quadratic formula.
- Determine when the solution to an equation is extraneous.
- Recognize that the solution(s) to an equation are the zeros of the function.
- Identify one-to-one functions using equations and tables of ordered pairs.
- Read and interpret the notation of a piecewise function.

### DO

- Use algebra to determine the domain of a radical and rational function.
- Find the zeros of an absolute value, quadratic, radical and rational function algebraically.
- Determine algebraically if an absolute value, quadratic or rational function is even, odd, or neither.
- Find the equation of the inverse of a quadratic, radical, and rational function.
- Verify using function composition that two functions are inverses.
- Use operations with functions to simplify expressions.
- Evaluate, graph, and write equations of piecewise functions.
- Compose functions algebraically and using tables of ordered pairs.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #2:** Polynomial and Rational Functions

**GRADE:** 11 – 12

## STANDARDS:

### PA Core Standards:

- CC.2.2.HS.C.1 • Use the concept and notation of functions to interpret and apply them in terms of their context.
- CC.2.2.HS.C.2 • Graph and analyze functions and use their properties to make connections between the different representations.
- CC.2.2.HS.C.3 • Write functions or sequences that model relationships between two quantities.
- CC.2.2.HS.C.4 • Interpret the effects transformations have on functions and find the inverses of functions.
- CC.2.2.HS.C.5 • Construct and compare linear, quadratic, and exponential models to solve problems.
- CC.2.1.HS.C.6 • Interpret functions in terms of the situations they model.
- CC.2.1.HS.D.2 • Write expressions in equivalent forms to solve.
- CC.2.1.HS.D.3 • Extend the knowledge of arithmetic operations and apply to polynomials.
- CC.2.1.HS.D.4 • Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs.
- CC.2.1.HS.D.5 • Use polynomial identities to solve problems.
- CC.2.1.HS.D.6 • Extend the knowledge of rational functions to rewrite in equivalent forms.
- CC.2.2.HS.D.7 • Create and graph equations or inequalities to describe numbers or relationships.
- CC.2.2.HS.D.9 • Use reasoning to solve equations and justify the solution method.
- CC.2.2.HS.D.10 • Represent, solve, and interpret equations/inequalities, and systems of equations/inequalities algebraically and graphically.
- CC.2.2.HS.F.7 • Apply concepts of complex numbers in polynomial identities and quadratic equations to solve problems.

### The Standards of Mathematical Practices:

- 1 Make sense of problems and persevere in solving them.
- 2 Reason abstractly and quantitatively.
- 4 Model with mathematics.
- 5 Use appropriate tools strategically.
- 7 Look for and make use of structure.
- 8 Look for and express regularity in repeated reasoning.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #2:** Polynomial and Rational Functions

**GRADE:** 11 – 12

## UNDERSTANDINGS

If  $f$  is a polynomial function and  $a$  is a real number, the following statements are equivalent:

- $x = a$  is a **zero** of the function  $f$ .
- $x = a$  is a **solution** of the polynomial equation  $f(x) = 0$ .
- $(x - a)$  is a **factor** of the polynomial  $f(x)$ .
- $(a, 0)$  is an **x-intercept** of the graph of  $f$ .

A rational function is a quotient of polynomial functions. Because the domain of a rational function excludes values that make the denominator equal zero, asymptotes and holes impact the graph.

## COMMON ASSESSMENTS/CULMINATING ACTIVITY

Polynomial Regression Math Lab/ Unit Test

### KNOW

- Recognize that a zero, solution to  $f(x)=0$ , factor, and x-intercept are all equivalent.
- Recognize that rational functions are a quotient of polynomials.
- Recognize the relationship between the asymptotes of a rational function and its domain and range.
- Recognize how the leading coefficient and degree of a polynomial affect its end behavior on the graph.
- Determine when a function is continuous or discontinuous.
- Determine the multiplicity of a factor of a polynomial given its graph.

### DO

- Graph a polynomial without a graphing calculator.
- Write the equation of a polynomial given its zeros.
- Divide polynomials using synthetic division and long division.
- Apply the Factor Theorem and Remainder Theorem to completely factor and solve a polynomial.
- Simplify and perform operations with radicals and complex numbers.
- Find the equation of all asymptotes (vertical, horizontal, oblique) and location of all holes in the graph of a rational function.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #3:** Exponential and Logarithmic Functions

**GRADE:** 11 – 12

## STANDARDS:

### PA Core Standards:

- CC.2.2.HS.C.2 • Graph and analyze functions and use their properties to make connections between the different representations.
- CC.2.2.HS.C.3 • Write functions or sequences that model relationships between two quantities.
- CC.2.2.HS.C.4 • Interpret the effects transformations have on functions and find the inverses of functions.
- CC.2.2.HS.C.5 • Construct and compare linear, quadratic, and exponential models to solve problems.
- CC.2.1.HS.C.6 • Interpret functions in terms of the situations they model.
- CC.2.2.HS.D.2 • Write expressions in equivalent forms to solve problems.
- CC.2.2.HS.D.7 • Create and graph equations or inequalities to describe numbers or relationships.
- CC.2.2.HS.D.8 • Apply inverse operations to solve equations or formulas for a given variable.
- CC.2.2.HS.D.9 • Use reasoning to solve equations and justify the solution method.
- CC.2.2.HS.D.10 • Represent, solve, and interpret equations/inequalities, and systems of equations/inequalities algebraically and graphically.

### The Standards of Mathematical Practices:

- 1 Make sense of problems and persevere in solving them.
- 2 Reason abstractly and quantitatively.
- 4 Model with mathematics.
- 5 Use appropriate tools strategically.
- 7 Look for and make use of structure.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #3:** Exponential and Logarithmic Functions

**GRADE:** 11 – 12

## UNDERSTANDINGS

Exponential and logarithmic functions are inverses of each other; their graphs are reflections of each other in the line  $y=x$ . They increase and decrease much faster than algebraic functions and cannot be written as a combination of polynomials (transcendental).

## COMMON ASSESSMENTS/CULMINATING ACTIVITY

Modeling Exponential Growth Lab; Unit Test

### KNOW

- Recognize that logs and exponential functions are inverses of each other.
- Recognize the relationship between properties of exponents and logs.
- Recognize the parent graphs of exponential and log functions.
- Classify logs by base.

### DO

- Evaluate exponential and log functions.
- Apply transformations to produce the sketch of an exponential or log graph without using a graphing calculator.
- Calculate compound and continuously compounded interest.
- Solve problems involving exponential growth and decay.
- Apply properties of exponents and logs to simplify expressions.
- Solve exponential and log equations.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #4A:** Trigonometric Functions

**GRADE:** 11 – 12

## STANDARDS:

### PA Core Standards:

- CC.2.2.HS.C.3 • Write functions or sequences that model relationships between two quantities.
- CC.2.2.HS.C.4 • Interpret the effects transformations have on functions and find the inverses of functions.
- CC.2.1.HS.C.6 • Interpret functions in terms of the situations they model.
- CC.2.1.HS.C.7 • Apply radian measure of an angle and the unit circle to analyze the trigonometric functions.
- CC.2.2.HS.D.2 • Write expressions in equivalent forms to solve problems.
- CC.2.2.HS.D.8 • Apply inverse operations to solve equations or formulas for a given variable.
- CC.2.2.HS.D.9 • Use reasoning to solve equations and justify the solution method.

### The Standards of Mathematical Practices:

- 1 Make sense of problems and persevere in solving them.
- 2 Reason abstractly and quantitatively.
- 4 Model with mathematics.
- 5 Use appropriate tools strategically.
- 6 Attend to precision.
- 7 Look for and make use of structure.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #4A:** Trigonometric Functions

**GRADE:** 11 – 12

## UNDERSTANDINGS

Trigonometry is used to find relationships between the sides and angles of triangles and to write trigonometric functions as models of real-world quantities that are periodic (cyclic).

## COMMON ASSESSMENTS/CULMINATING ACTIVITY

Forest Fires Math Journal/ Unit Test

### KNOW

- Recognize the relationship between radian and degree angle measures.
- Commit the special angles on the unit circle to memory.
- Distinguish between a coterminal angle and a reference angle.
- Recognize the relationship between trig functions and their cofunctions.

### DO

- Convert between radian and degree measure.
- Find the complement and supplement of a given angle in radians and degrees.
- Evaluate trig functions of special angles on the unit circle and with a graphing calculator.
- Find the values of trig functions of an angle in standard position given a point on its terminal side.
- Solve a right triangle using trig functions and their inverses.
- Solve non-right triangles using the law of sines and law of cosines.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #4B:** Graphs of Trigonometric Functions

**GRADE:** 11 – 12

## STANDARDS:

### PA Core Standards:

- CC.2.2.HS.C.2 • Graph and analyze functions and use their properties to make connections between the different representations.
- CC.2.2.HS.C.3 • Write functions or sequences that model relationships between two quantities.
- CC.2.2.HS.C.4 • Interpret the effects transformations have on functions and find the inverses of functions.
- CC.2.2.HS.C.6 • Interpret functions in terms of the situations they model.
- CC.2.1.HS.C.7 • Apply radian measure of an angle and the unit circle to analyze the trigonometric functions.
- CC.2.2.HS.C.8 • Choose trigonometric functions to model periodic phenomena and describe the properties of the graphs.
- CC.2.2.HS.D.7 • Create and graph equations or inequalities to describe numbers or relationships.

### The Standards of Mathematical Practices:

- 1 Make sense of problems and persevere in solving them.
- 2 Reason abstractly and quantitatively.
- 4 Model with mathematics.
- 5 Use appropriate tools strategically.
- 6 Attend to precision.
- 7 Look for and make use of structure.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #4B:** Graphs of Trigonometric Functions

**GRADE:** 11 – 12

## UNDERSTANDINGS

Amplitude, period, phase shift, and vertical displacement affect the appearance of the graph of the parent trigonometric functions. Amplitude stretches or shrinks the graph vertically. Period stretches or shrinks the graph horizontally. Phase shift translates the graph left or right. Vertical displacement translates the graph up or down. The cosine curve is a phase shift of the sine curve and both are continuous. The tangent curve is discontinuous because it is undefined where cosine is zero. The x-intercepts of the sine and cosine curves become vertical asymptotes of the cosecant and secant curves.

## COMMON ASSESSMENTS/CULMINATING ACTIVITY

Weather Patterns Project/ Unit Test

### KNOW

- Recognize the parent graphs of each trigonometric function.
- Recognize the relationships between the parent graphs of each trigonometric function.
- Recognize the relationship between the graphs of a trigonometric function and its inverse.

### DO

- Use transformations to change the graph of a trigonometric function.
- Write the equation of trigonometric function given the amplitude, period, phase shift, and/or vertical displacement.
- Write the equation of a trigonometric function given its graph.
- Model periodic data using best-fit equations.
- Find the principal values of inverse trigonometric functions.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #5:** Trigonometric Identities and Equations

**GRADE:** 11 – 12

## STANDARDS:

### PA Core Standards:

- CC.2.2.HS.C.2 • Graph and analyze functions and use their properties to make connections between the different representations.
- CC.2.1.HS.C.7 • Apply radian measure of an angle and the unit circle to analyze the trigonometric functions.
- CC.2.2.HS.C.9 • Prove the Pythagorean identity and use it to calculate trigonometric ratios.
- CC.2.2.HS.D.7 • Create and graph equations or inequalities to describe numbers or relationships.

### The Standards of Mathematical Practices:

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

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #5:** Trigonometric Identities and Equations

**GRADE:** 11 – 12

## UNDERSTANDINGS

Trigonometric expressions can be factored, added, subtracted, multiplied, divided, and simplified the same way algebraic expressions are. They are different in that to simplify many trigonometric expressions, you must substitute an identity into the expression. To solve a trigonometric equation, you use standard algebraic techniques, like combining like terms, factoring, and extracting square roots. Unlike algebraic equations, trigonometric equations often have multiple angles as their solution.

## COMMON ASSESSMENTS/CULMINATING ACTIVITY

Unit Test

### KNOW

- Recognize when to use the following identities to simplify and/or verify a trigonometric expression: reciprocal, quotient, Pythagorean, cofunction, and even/odd.

### DO

- Use identities to evaluate a trigonometric function.
- Add, subtract, multiply and factor trigonometric expressions.
- Rewrite trigonometric expressions to eliminate fractions.
- Verify trigonometric identities algebraically and graphically.
- Solve trigonometric equations algebraically and graphically.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #6:** Conic Sections

**GRADE:** 11 – 12

## STANDARDS:

### PA Core Standards:

- CC.2.2.HS.A.10 • Translate between the geometric description and the equation for a conic section.
- CC.2.2.HS.A.14 • Apply geometric concepts to model and solve real world problems.
- CC.2.2.HS.D.7 • Create and graph equations or inequalities to describe numbers or relationships.
- CC.2.2.HS.D.10 • Represent, solve, and interpret equations/inequalities, and systems of equations/inequalities algebraically and graphically.

### The Standards of Mathematical Practices:

- 1 Make sense of problems and persevere in solving them.
- 2 Reason abstractly and quantitatively.
- 4 Model with mathematics.
- 5 Use appropriate tools strategically.
- 7 Look for and make use of structure.

# KNOW, UNDERSTAND, DO

**COURSE:** Pre-Calculus

**TIME FRAME:** 4.5 weeks

**UNIT #6:** Conic Sections

**GRADE:** 11 – 12

## UNDERSTANDINGS

Circles, parabolas, ellipses, and hyperbolas are conic sections formed from cross sections of a double-napped cone. Conic sections can be used to model real world problems such as planetary orbits, parabolic mirrors, trajectory and navigation systems, and systems with circular properties such as wheels and gears.

## COMMON ASSESSMENTS/CULMINATING ACTIVITY

Conics Project/ Unit Test

### KNOW

- Recognize the relationship between a cone and each conic section.
- Recognize the relationship between a circle and an ellipse.
- Recognize each conic section by shape and equation.
- Identify all features on the graph of each conic section, including vertices, foci, center, axis of symmetry, directrix, axes, and/or asymptotes.
- Identify real world applications of conic sections.

### DO

- Graph each conic section given its equation.
- Write the equation of each conic section given its graph, or information about the graph.
- Use conic sections to model and solve real world problems.

## **Adaptations/Modifications for Students with I.E.P.s**

Adaptations or modifications to this planned course will allow exceptional students to earn credits toward graduation or develop skills necessary to make a transition from the school environment to community life and employment. The I.E.P. team has determined that modifications to this planned course will meet the student's I.E.P. needs.

Adaptations/Modifications may include but are not limited to:

### **INSTRUCTION CONTENT**

- Modification of instructional content and/or instructional approaches
- Modification or deletion of some of the essential elements

### **SETTING**

- Preferential seating

### **METHODS**

- Additional clarification of content
- Occasional need for one to one instruction
- Minor adjustments or pacing according to the student's rate of mastery
- Written work is difficult, use verbal/oral approaches
- Modifications of assignments/testing
- Reasonable extensions of time for task/project completion
- Assignment sheet/notebook
- Modified/adjusted mastery rates
- Modified/adjusted grading criteria
- Retesting opportunities

### **MATERIALS**

- Supplemental texts and materials
- Large print materials for visually impaired students
- Outlines and/or study sheets
- Carbonless notebook paper
- Manipulative learning materials
- Alternatives to writing (tape recorder/calculator)