Pre-Calculus U-46 Curriculum Scope and Sequence

Reporting Strand	Instructional Focus	Common Core Standards	Sem.	
Compose and Transform Functions	Compose and transform functions	F-BF-3(+), F-BF-1c	1	
Inverses and Rational	Produce inverse functions	F-BF- 4	1	
Functions	Graph and interpret rational functions	F-IF-7	1	
Exponential and	Graph and interpret exponential and logarithmic functions	F-IF-7, F-BF-3(+)	1	
Logarithmic Functions	Use inverse relationships to solve problems	F-BF-5	1	
	Explore sequences	F.BF.1, F.IF.3		
Series and Conics	Use finite and infinite formulas to solve problems	A-SSE-4 (+)	1/2	
	Derive the equations of ellipses and hyperbolas	G-GPE-2, G-GPE-3		
Unit Circle and Inverse Trigonometry	Inverse Use unit circles and inverse trigonometric		2	
Graph and Transform Trigonometry	Transform Graph and transform trigonometric functions		2	
Prove and Use Trigonometry	Prove and use trigonometric functions	G-SRT-9, G-SRT.10, G-SRT.11, F-TF-9, F-TF-8	2	
	Find limits and continuity	Calculus Prep		
Limits and Coordinate Systems	Represent and calculate with vectors	N-VM-1, N-VM-2, N-VM-3, N-VM-4, N-VM-5	2	
Systems	Represent and calculate complex numbers	N-CN-4, N-CN-3, N-CN-5, N-CN-6		

FunctionsInstructional Focus: Compose and transform functions

	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No Evidence
Identify and Find Transfor- mations (F.BF.3)	Can extend thinking beyond the standard, including tasks that may involve one of the following: Designing Connecting Synthesizing Applying Justifying Critiquing Analyzing Creating Proving	Identify the effect on a graph by replacing f(x) with more than two transformations: f(x) + k, k f(x), f(kx), f(x+k) for specific positive and negative values of k, and graph the transformation Given the graph of a function and more than two transformations, find the values of the constants and coefficients Given a partial graph, complete the graph for both even and odd functions	Identify the effect on a graph by replacing f(x) with two transformations: f(x) + k, k f(x), f(kx), f(x+k) for specific positive and negative values of k, and graph the transformation Given the graph of a function and two transformations, find the values of the constants and coefficients Recognize even and odd functions from graphs and equations	Identify the effect on a graph by replacing f(x) with a single transformation: f(x) + k, k f(x), f(kx), f(x + k) for specific positive and negative values of k Given the graph of a function and a single transformation, find the value of the constant or coefficient Recognize even and odd functions from graphs or equations	Little evidence of reasoning or application to solve the problem Does not meet the criteria in a level 1
Compose Functions (F.BF.1c)		Evaluate the composition of 2 functions in context of a situation	Evaluate the <u>composition of 2</u> <u>functions</u>	Evaluate a function for a given value and use that result to evaluate a second function	

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. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F.BF.1c 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.

Functions

Instructional Focus: Produce inverse functions

	4 Mastani	3 – Proficient	2 - Basic	1 – Below Basic	0 – No
	4 – Mastery	5 - Proficient	Z - Dasic	1 – Below Basic	Evidence
Produce	Can extend	Compose functions to verify	Compose functions to verify	Given a simple function,	Little
inverse	thinking beyond	if one function is the inverse	if one function is the inverse	find its inverse	evidence
functions	the standard,	of another function	of another function	Read values of an inverse	of
(F.BF.4)	including tasks	Read values of an inverse	Read values of an inverse	function from a graph <u>or</u>	reasoning
	that may involve	function from a graph and	function from a graph and	table	or
	one of the	table	table		application
	following:				to solve
		Produce an invertible	Identify a domain that that	Identify if a function is	the
	 Designing 	function from a non-	will produce an invertible	invertible from a graph	problem
	Connecting	invertible function by	function from a non-		
	 Synthesizing 	restricting the domain so	invertible function		Does not
	Applying	that the function is one-to-			meet the
	Justifying	one			criteria in
	Critiquing				a level 1
	Analyzing				
	Creating				
	 Proving 				

F.BF.4 Find inverse functions.

- 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.
- d. (+) Produce an invertible function from a non-invertible function by restricting the domain.

FunctionsInstructional Focus: Graph and interpret rational functions

	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No Evidence
Identify key features of graphs (F.IF.7)	Can extend thinking beyond the	Graph rational functions, given the	Graph rational functions, given the	Given the graphs of rational functions,	Little evidence
graphs (F.IF.7) The concentration C (in mg/dl), of a certain prescription drug in a person's bloodstream is determined using the rational function: $C(t) = \frac{50t}{t^2 + 25}$ where t is the time (in hours) after taking the prescription drug What is the equation of the horizontal asymptote for the graph of the function? What does this value (and the fact that it is an asymptote) represent in the context of this problem?	beyond the standard, including tasks that may involve one of the following: Designing Connecting Synthesizing Applying Justifying Critiquing Analyzing Creating Proving	functions, given the model, and interpret all related key features of a graph in context of a real world situation. • equations of asymptotes • intercepts (x and y) • end behavior	functions, given the model, and identify all related key features of a graph. • equations of asymptotes • intercepts (x and y) • end behavior	rational functions, identify all related key features of a graph. equations of asymptotes intercepts (x and y) end behavior	evidence of reasoning or application to solve the problem Does not meet the criteria in a level 1

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. ★

d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

Exponential and Logarithmic Functions

Instructional Focus: Graph and interpret exponential and logarithmic functions

	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No Evidence
Identify	Can extend	Identify the effect on a	Identify the effect on a	Identify the effect on a	Little
and Find	thinking beyond	graph by replacing f(x) with	graph by replacing f(x) with	graph by replacing f(x) with	evidence
Transfor-	the standard,	more than two	two transformations:	a single transformation:	of
mations	including tasks	transformations:	f(x) + k, k f(x),	f(x) + k, k f(x),	reasoning
(F.BF.3)	that may involve	f(x) + k, k f(x),	f(kx), $f(x + k)$ for specific	f(kx), $f(x + k)$ for specific	or
	one of the	f(kx), $f(x + k)$ for specific	positive and negative values	positive and negative values	application
	following:	positive and negative values	of k	of k	to solve
		of k			the
	 Designing 		Given the graph of a	Given the graph of a	problem
	 Connecting 	Given the graph of a	function and two	function and a single	
	Synthesizing	function and more than two	transformations, find the	transformation, find the	Does not
	Applying	transformations, find the	values of the constants and	value of the constant or	meet the
	 Justifying 	values of the constants and	coefficients	coefficient	criteria in
	Critiquing	coefficients			a level 1
Identify key	Analyzing	Graph exponential and	Graph exponential and	Given the graphs of	
features of	Creating	logarithmic functions, and	logarithmic functions, and	exponential and logarithmic	
graphs	Proving	interpret all related key	identify all related key	functions, and identify all	
(F.IF.7)		features of a graph <u>in</u>	features of a graph.	related key features of a	
		context of a real world	 equations of 	graph.	
		<u>situation</u> .	asymptotes	 equations of 	
		 equations of 	intercepts (x and y)	asymptotes	
		asymptotes	end behavior	intercepts (x and y)	
		intercepts (x and y)		end behavior	
		 end behavior 			

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. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

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. ★

d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

e. (+) Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

Exponential and Logarithmic Functions

Instructional Focus: Use inverse relationships to solve exponential and logarithmic problems

	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No Evidence
Exponential	Can extend	Recognize that exponential	Recognize that exponential	Recognize that exponential	Little
and	thinking beyond	and logarithmic functions	and logarithmic functions	and logarithmic functions	evidence
Logarithmic	the standard,	are inverses of each other	are inverses of each other	are inverses of each other	of
inverses	including tasks	and use these functions to	and use these functions to	and convert from one form	reasoning
(F.BF.5)	that may involve	solve real-world problems .	solve logarithmic and	into the other.	or
	one of the		exponential equations.		application
	following:				to solve
					the
	 Designing 				problem
	 Connecting 				
	 Synthesizing 				Does not
	 Applying 				meet the
	 Justifying 				criteria in
	 Critiquing 				a level 1
	 Analyzing 				
	 Creating 				
	Proving				

F.BF.5 (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Series and Conics

Instructional Focus: Explore sequences

	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No Evidence
Recursive and Explicit Functions (F.BF.1a, F.IF.3, A.SSE.4)	Can extend thinking beyond the standard, including tasks that may involve one of the following: Designing Connecting Synthesizing Applying Justifying Critiquing Analyzing Creating Proving	Write an explicit formula to model a situation in context. Use an explicit formula to find any term(s) in a sequence given two nonconsecutive terms.	Write an explicit formula to model a situation in context. Use an explicit and recursive function to find any term(s) in a sequence.	Write an explicit and recursive function for an arithmetic or geometric sequence. Identify characteristics (first term, common ratio, etc) of an arithmetic or geometric sequence.	Little evidence of reasoning or application to solve the problem Does not meet the criteria in a level 1

Series and Conics

Instructional Focus: Use finite and infinite formulas to solve problems

	4 – Mastery	3 – Proficient	2 - Basic	1 – Rolow Rasis	0 – No
	4 - Iviastei y	3 - Floricient	2 - Dasic	1 – Below Basic	Evidence
Finite and	Can extend	Use the finite and infinite	Use the finite and infinite	Find the sum, using the	Little
infinite	thinking beyond	formulas for geometric	formulas for geometric	finite and infinite	evidence
formulas	the standard,	series to solve real-world	series to find:	formulas, for geometric	of
(A.SSE.4)	including tasks	<u>problems</u>	• sum	series	reasoning
	that may involve		 <u>first term</u> 		or
	one of the		• <u>last term</u>		application
	following:		• <u>rate</u>		to solve
					the
	 Designing 				problem
	 Connecting 				
	 Synthesizing 				
	Applying				Does not
	 Justifying 				meet the
	 Critiquing 				criteria in
	 Analyzing 				a level 1
	 Creating 				
	Proving				

A.SSE.4 (edited) Use the finite **and infinite formulas** for geometric series to solve problems. For example, calculate mortgage payments. ★

Series and Conics

Instructional Focus: Derive the equation of ellipses and hyperbolas

	4 Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No
	4 – Mastery	5 - Proficient	Z - Dasic	I – Below Basic	Evidence
Conics (G.GPE2,	Can extend	Write the equation of a	Identify the equation of a	Identify the focus and	Little
G.GPE.3)	thinking beyond	parabola given its focus	parabola given its focus	directix of a parabola	evidence of
	the standard,	and directrix.	and directrix.		reasoning
. 1	including tasks				or
30	that may involve	Write the standard	Write the standard	<u>Identify</u> if a given	application
30	one of the	equation of an ellipse or	equation of a hyperbola	equation represents an	to solve the
30 072,139	following:	hyperbola given the	or ellipse given the graph	ellipse or hyperbola	problem
-10 20 30		graph, foci, or general			
	 Designing 	form of the equation.			
	Connecting				Does not
	 Synthesizing 	Identify the center,	Identify the center and	Identify the center of an	meet the
	Applying	vertices, and foci given	<u>vertices</u> of an ellipse or	ellipse or hyperbola given	criteria in a
	Justifying	the equation of an ellipse	hyperbola given the graph	the graph or equation	level 1
	Critiquing	or hyperbola	or equation		
	Analyzing				
	Creating				
	Proving				

G.GPE.2 Derive the equation of a parabola given a focus and directrix.

G.GPE.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.

Trigonometry

Instructional Focus: Use unit circles and inverse trigonometric functions

	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No Evidence
Use special triangles (F.TF.3)	Can extend thinking beyond the standard, including tasks that may involve one of the following: Designing Connecting Synthesizing	Use special triangles to determine the values of sine, cosine, tangent, secant, cosecant, and cotangent for 0 , $\pi/6$, $\pi/4$ and $\pi/3$, $\pi/2$ and use the unit circle to express the values of sine, cosine, tangent, secant, cosecant, and cotangent for $\pi-x$, $\pi+x$, and $2\pi-x$ in terms of their values for x , where x is any real number	Use special triangles to determine the values of sine, cosine, tangent, secant, cosecant, and cotangent for 0 , $\pi/6$, $\pi/4$, $\pi/3$ and $\pi/2$	Use special triangles to determine the values of sine, cosine and tangent for $\pi/6$, $\pi/4$ and $\pi/3$	Little evidence of reasoning or application to solve the problem
Use unit circles to find values (F.TF.4) Construct Inverse trigonometric functions (F.TF.6)	 Applying Justifying Critiquing Analyzing Creating Proving 	Use the unit circle to express any angle, including negative angles and angles involving more than 1 rotation, in terms of its standard position to find all six trigonometric functions. Construct an invertible trigonometric function by restricting the domain so that the function is always increasing or decreasing	Use the unit circle to express any angle, between 0 and 2π , in terms of its standard position to find ALL 6 trig functions. Identify a domain that will allow construction of the inverse of a trigonometric function, because the function would be always increasing or decreasing	Use the unit circle to express any angle, between 0 and 2π , in terms of its standard position to find the <u>sine</u> , <u>cosine</u> , <u>and tangent functions</u> . Given a portion of a trigonometric graph, identify if that part of the graph is invertible	Does not meet the criteria in a level 1
Use inverse trigonometric functions (F.TF.7) Pythagorean identity (F.TF.8) Given cos θ = 2		Use inverse functions to solve trigonometric equations with restricted and unrestricted domains and interpret the solutions in context of the situation Prove the Pythagorean identity $sin^2(\theta) + cos^2(\theta) = 1$ and use it to find $sin(\theta)$, $cos(\theta)$, and $tan(\theta)$	Use inverse functions to solve trigonometric equations with restricted and unrestricted domains Use the Pythagorean identity $sin^2(\theta) + cos^2(\theta) = 1$ to find $sin(\theta)$, $cos(\theta)$, and $tan(\theta)$	Use inverse functions to solve trigonometric equations with <u>restricted domains</u> Use the Pythagorean identity $sin^2(\theta) + cos^2(\theta) = 1$ to find $sin(\theta)$, $cos(\theta)$, <u>or</u> $tan(\theta)$	

F.TF.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. Functions F.TF.4 (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

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.

F.TF.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. ★

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.

Trigonometry

Instructional Focus: Graph and transform trigonometric functions

	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No
Cumamaatra	Can extend	Lica the unit circle to evalein	Use the unit circle to explain	Lico the unit circle to evalein	Evidence Little
Symmetry and	thinking beyond	Use the unit circle to explain symmetry (odd and even) of	symmetry (odd and even) of	Use the unit circle to explain symmetry (odd and even) of	evidence
					of
periodicity of trigono-	the standard, including tasks	the six trigonometric functions.	the sine, cosine, <u>and</u>	the <u>sine and cosine</u> functions.	
metric		Tunctions.	tangent functions.	Tunctions.	reasoning
	that may involve	Heatha pariadicity of the	Licatha pariadiaity of the	Heatha pariadisity of the	Or
functions	one of the following:	Use the periodicity of the	Use the periodicity of the	Use the periodicity of the	application to solve
(F.TF.4)	Tollowing.	unit circle to explain the repeated cycle of the graphs	unit circle to explain the repeated cycle of the graphs	unit circle to explain the repeated cycle of the graphs	the
			, ,	' ' ' ' ' ' '	
	 Designing 	of <u>all six</u> trigonometric functions.	of sine, cosine, <u>and tangent</u> functions.	of <u>sine and cosine</u> functions.	problem Does not
Idootif.	Connecting	Identify the effect on a	Identify the effect on a	Identify the effect on a	meet the
Identify	 Synthesizing 		· ·	· · · · · · · · · · · · · · · · · · ·	
and Find	Applying	graph by replacing f(x) with	graph by replacing f(x) with	graph by replacing f(x) with	criteria in
Transfor-	 Justifying 	more than two	two transformations:	a single transformation:	a level 1
mations	Critiquing	transformations:	f(x) + k, k f(x), f(kx), f(x+k)	f(x) + k, k f(x), f(kx), f(x+k)	
(F.BF.3)	Analyzing	f(x) + k, k f(x), f(kx), f(x+k)	for specific positive and	for specific positive and	
	 Creating 	for specific positive and	negative values of k	negative values of k	
	Proving	negative values of k			
			Given the graph of a	Given the graph of a	
		Given the graph of a	function and <u>two</u>	function and a single	
		function and more than two	transformations, find the	transformation, find the	
		transformations, find the	values of the constants and	value of the constant or	
		values of the constants and coefficients	coefficients	coefficient	
		Coemicinis	Recognize even and odd	Recognize even and odd	
		Given a partial graph,	functions from graphs and	functions from graphs	
		complete the graph for	<u>equations</u>		
		both even and odd			
		functions			
Identify key		Graph trigonometric	Graph trigonometric	Given the graph or	
features of		functions, and interpret all	functions, and identify all	equation of trigonometric	
graphs		related key features of a	related key features of a	functions, identify all	
(F.IF.7)		graph in context of a real	graph.	related key features of a	
		world situation.	asymptotes	graph.	
		asymptotes	period	asymptotes	
		period	midline	period	
		midline	 amplitude 	midline	
		 amplitude 		 amplitude 	

Graphing F.TF.4 (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

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. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

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 exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

Trigonometry

Instructional Focus: Prove and use trigonometric functions

	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No
	4 – Iviastery	5 - Proficient	Z - Dasic	1 – Below Basic	Evidence
Prove and	Can extend	Prove the addition and	Prove the addition and	Use the addition,	Little
use	thinking beyond	subtraction formulas for	subtraction formulas for	subtraction, and tangent	evidence
formulas	the standard,	sine, cosine, and tangent	sine, cosine, and tangent	formulas to solve numerical	of
(F.TF.9)	including tasks	and use the addition and	and use them to solve	problems	reasoning
	that may involve	subtraction formulas to	numerical problems		or
	one of the	solve <u>identities</u>			application
	following:				to solve
Derive		Explain how to derive the	Explain how to derive the	Find the area of any triangle	the
area	Designing	formula: $A = 1/2 ab \sin(C)$	formula: $A = 1/2 ab \sin(C)$	using the formula:	problem
formula	Designing	for the area of a triangle,	for the area of a triangle,	$A = 1/2 \ ab \ \sin(C)$	p. 00.0
(G.SRT.9)	- connecting	and utilize it to find the area	and utilize it to find the area		Does not
	Synthesizing	of a polygon composed of	of a triangle		meet the
	Applying	multiple triangles			criteria in
	Justifying				a level 1
Law of	Critiquing	Apply the Law of Sines and	Apply the Law of Sines <u>and</u>	Apply the Law of Sines <u>or</u>	a level 1
Sines and	 Analyzing 	the Law of Cosines to find	the Law of Cosines to find	the Law of Cosines to find	
Cosines	 Creating 	unknown measurements in	unknown measurements in	unknown measurements in	
(G.SRT.10	Proving	oblique triangles <u>and</u>	oblique triangles	oblique triangles	
and 11)		interpret solutions in			
		context of real-world			
		situations			

F.TF.9 (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

G.SRT.9 (+) 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.

G.SRT.10 (+) Prove the Laws of Sines and Cosines and use them to solve problems.

G.SRT.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).

Coordinate Systems

Instructional Focus: Represent and calculate with vectors

	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No
	4 – iviastery	5 – Proficient	Z - Dasic		Evidence
Represent	Can extend	Use appropriate symbols for	Use appropriate symbols for	Use appropriate symbols	Little
vectors	thinking beyond	vectors and their	vectors and their magnitude	for vectors and their	evidence
(N.VM.1)	the standard,	magnitude, represent	and represent vector	<u>magnitude</u>	of
	including tasks	vector quantities by	quantities by directed line		reasoning
	that may involve	directed line segments, and	segments.		or
	one of the	find the magnitude and			application
	following:	direction of vector			to solve
		quantities.			the
	 Designing 				problem
Solve	Connecting	Solve problems involving	Solve problems involving	Solve problems involving	
problems	 Synthesizing 	velocity and other	velocity and other	velocity and other	Does not
with	 Applying 	quantities by converting	quantities by converting	quantities by converting	meet the
vectors	Justifying	given direction and	given direction and	given direction and	criteria in
(N.VM.3)	Critiquing	magnitude quantities into	magnitude quantities into	magnitude quantities into	a level 1
	 Analyzing 	component vectors,	component vectors, and	component vectors	
	 Creating 	calculate the resultant	calculate the resultant		
	 Proving 	vector, and find the	vector		
		resultant direction and			
		magnitude or the angle			
		between vectors			
Operations		Find the components of a	Find the components of a	Find the components of a	
with		vector by subtracting	vector by subtracting	vector by subtracting	
vectors		coordinates	coordinates	coordinates	
(N.VM.2,		Add, subtract vectors	Add, subtract vectors	Add, subtract vectors	
N.VM.4,		graphically and component-	graphically <u>and</u> component-	graphically <u>or</u> component-	
N.VM.5)		wise, and determine the	wise	wise	
		magnitude and direction	Multiply a vector by a scalar	Multiply a vector by a scalar	
		Multiply a vector by a scalar			
		and determine the			
		magnitude and direction			

N.VM.1 (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., \mathbf{v} , $|\mathbf{v}|$, $|\mathbf{v}|$, $|\mathbf{v}|$, $|\mathbf{v}|$, $|\mathbf{v}|$, $|\mathbf{v}|$.

N.VM.3 (+) Solve problems involving velocity and other quantities that can be represented by vectors.

N.VM.2 (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

N.VM.4 (+) Add and subtract vectors.

- a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.
- b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.
- c. Understand vector subtraction $\mathbf{v} \mathbf{w}$ as $\mathbf{v} + (-\mathbf{w})$, where $-\mathbf{w}$ is the additive inverse of \mathbf{w} , with the same magnitude as \mathbf{w} and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.

N.VM.5 (+) Multiply a vector by a scalar.

- a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication componentwise, e.g., as c(vx, vy) = (cvx, cvy).
- b. Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for c > 0) or against v (for c < 0).

Coordinate Systems

Instructional Focus: Represent and calculate complex numbers

	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No
Represent on the complex plane (N.CN.4) Operations of Vectors in Polar Form (N.CN.3, N.CN.5)	A – Mastery Can extend thinking beyond the standard, including tasks that may involve one of the following: Designing Connecting Synthesizing Applying Justifying Critiquing Analyzing Creating Proving	Represent complex numbers on the complex plane in rectangular and polar form, and explain why the rectangular and polar forms of a given complex number represent the same number Represent and compute addition and subtraction_of complex numbers geometrically on the complex plane Represent and compute multiplication and division, in polar form, of complex numbers geometrically on the complex plane Represent and compute multiplication and division, in polar form, of complex numbers geometrically on the complex plane Represent and compute the power and roots of complex numbers, in polar form.	Represent complex numbers on the complex plane in rectangular and polar form Represent and compute addition and subtraction_of complex numbers geometrically on the complex plane Represent and compute multiplication and division, in polar form, of complex numbers geometrically on the complex plane	Represent complex numbers on the complex plane in rectangular form Represent and compute addition and subtraction of complex numbers geometrically on the complex plane	Evidence Little evidence of reasoning or application to solve the problem Does not meet the criteria in a level 1
Calculate distance and midpoint (N.CN.6)		Calculate the distance between numbers in the complex plane as the modulus of the difference, and calculate the midpoint of a segment in the complex plane as the average of the numbers at its endpoints	Calculate the difference between numbers in the complex plane, and calculate the midpoint of a segment in the complex plane as the average of the numbers at its endpoints	Calculate the midpoint of a segment in the complex plane as the average of the numbers at its endpoints	

- N.CN.4 (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.
- N.CN.3 (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.
- N.CN.5 (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $(-1 + \sqrt{3} i)^3 = 8$ because $(-1 + \sqrt{3} i)$ has modulus 2 and argument 120°.
- N.CN.6 (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

LimitsInstructional Focus: Find limits and continuity

	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No
					Evidence
Find limits	Can extend	Find limits and one-sided	Find limits and one-sided	Find limits and one-sided	Little
	thinking beyond	limits graphically,	limits graphically and	<u>limits</u> graphically and	evidence
	the standard,	numerically <u>, and</u>	numerically. Describe end	numerically	of
	including tasks	algebraically, using proper	behavior (as x approaches		reasoning
	that may involve	<u>notation.</u> Describe end	∞ or $-\infty$) using limit		or
	one of the	behavior (as x approaches	notation).		application
	following:	or -) using limit notation			to solve
					the
Determine	 Designing 	Determine continuity of	Determine continuity of	Determine continuity of	problem
continuity	 Connecting 	functions graphically,	functions graphically and	functions graphically and	
	 Synthesizing 	numerically, <u>and</u>	numerically on its domain	numerically at a given value	
	 Applying 	algebraically on its domain	using the three-part	using the three-part	Does not
	 Justifying 	using the three-part	definition of continuous	definition of continuous	meet the
	• Critiquing	definition of continuous	functions.	functions.	criteria in
	 Analyzing 	functions.			a level 1
	 Creating 				
	 Proving 	Determine values for which	Determine values for which	Determine values for which	
		a function is discontinuous,	a function is discontinuous,	a function is discontinuous.	
		understand the difference	and understand the		
		between removable and	difference between		
		nonremovable	removable and		
		discontinuities, and be able	<u>nonremovable</u>		
		to redefine functions to	discontinuities.		
		make them continuous			
		when possible.			
				Determine whether a one-	
		Find finite and infinite one-	<u>Find</u> finite and infinite one-	sided limit is finite or	
		sided limits, and describe	sided limits.	infinite.	
		asymptotes using limit		manage.	
		notation.			

Find limits and one-sided limits graphically, numerically, and algebraically, using proper notation. Describe end behavior (as x approaches or -) using limit notation.

Determine continuity of functions graphically, numerically, and algebraically on its domain using the three-part definition of continuous functions. Determine values for which a function is discontinuous, understand the difference between removable and nonremovable discontinuities, and be able to redefine functions to make them continuous when possible. Find finite and infinite one-sided limits, and describe asymptotes using limit notation.