S Functions and Graphs
e

	Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
p		Functions	Define a function	Functions				2.8.11.B-Evaluate and simplify algebraic expressions and solve and graph linear, quadratic, exponential, and logarithmic equations and inequalities, and solve and graph systems of equations and inequalities.
t			Determine if a relation is a function from multiple representations of data (graphs, tables, equations)					2.8.11.D-Demonstrate an understanding and apply properties of functions (domain, range, inverses) and characteristics of families of functions (linear, polynomial, rational, trigonometric, exponential, logarithmic).
e				Asymptotes				
m								
b				Domain				
e								
r				Range				
		Characteristics of functions	Determine the domain and range of a function from graph or equation	Even and Odd Functions				2.8.11.B-Evaluate and simplify algebraic expressions and solve and graph linear, quadratic, exponential, and logarithmic equations and inequalities, and solve and graph systems of equations and inequalities.
			Recognize even and odd functions in graphs and equations					2.8.11.D-Demonstrate an understanding and apply properties of functions (domain, range, inverses) and characteristics of families of functions (linear, polynomial, rational, trigonometric, exponential, logarithmic).
			Interpret and find formulas for piecewise functions	Domain				
				Range Piecewise Functions				

Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
	Graphs of functions	Recognize types of functions from a graph	Vertical and Horizontal Transformations				2.8.11.B-Evaluate and simplify algebraic expressions and solve and graph linear, quadratic, exponential, and logarithmic equations and inequalities, and solve and graph systems of equations and inequalities.
		Determine the equation of a function using transformations					2.8.11.D-Demonstrate an understanding and apply properties of functions (domain, range, inverses) and characteristics of families of functions (linear, polynomial, rational, trigonometric, exponential, logarithmic).
	Types of functions	Review, linear, polynomial, exponential, logarithmic and trig functions	Period				2.8.11.B-Evaluate and simplify algebraic expressions and solve and graph linear, quadratic, exponential, and logarithmic equations and inequalities, and solve and graph systems of equations and inequalities. 2.8.11.D-Demonstrate an understanding and apply properties of functions (domain, range, inverses) and characteristics of families of functions (linear, polynomial, rational, trigonometric, exponential, logarithmic).
			Ampltitude Vertex				

O
c
t
o
b
e
r

Limits and Continuity

Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
	Rates of change and limits	Calculate average and instantaneous speed	Limits				1.A.2-Calculating limits using algebra
		Define limits					1.A.3-Estimating limits from graphs or tables of data
		Apply properties of limits	One-Sided Limits				
		Determine limits from a graph, from a table and from the function equation					
		Apply the Sandwich Theorem to find limits					
			Two-Sided Limit Sandwich Theorem				

Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
	Limits involving infinity	Find and verify end behavior models for functions Calculate limits as x approaches infinity Determine limits that are infinite Identify horizontal and vertical asymptotes from limits	Limits as x approaches infinity Horizontal Asymptotes Vertical Asymptotes				1.B.1-Asymptotic and unbounded behavior-Understanding asymptotes in terms of graphical behavior 1.B.2-Describing asymptotic behavior in terms of limits involving infinity
	Continuity	Determine definition of continuity at a point	Jump Discontinuity				1.C.1-Continuity as a property of functions- An intuitive understanding of continuity. (The function values can be made as close as desired by taking sufficiently close values of the domain.)
		Determine points of discontinuity and the type of discontinuity Extend or modify a function with a removable discontinuity Apply properties combinations and compositions of continuous functions Apply the Intermediate Value Theorem to continuous functions	Removable Discontinuity Infinite Discontinuity				1.C.2-Understanding continuity in terms of limits

N
o
v
e

Derivatives

Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
	Rates of change and tangent lines						
	Derivative of a Function	Calculate slopes and derivatives using the definition of the derivative	Difference Quotient				2.A.1-Concept of the derivative-Derivative presented graphically, numerically, and analytically

m		Approximate derivatives numerically and graphically		2.A.2-Derivative interpreted as an instantaneous rate of change
b			Symmetric Difference Quotient	2.A.3-Derivative defined as the limit of the difference quotient
e				2.A.4-Relationship between differentiability and continuity
			Vertical Tangent	
			Cusp	
	Differentiability	Determine where a function is not differentiable Determine continuity from differentiability	Cusp	2.B.1-Derivative at a point- Slope of a curve at a point. Examples are emphasized, including points at which there are vertical tangents and points at which there are no tangents.
			Vertical Tangent	
			Jump Discontinuity	
	Rules for differentiation	Calculate derivatives (including second and higher order derivative) using the rules of differentiation	Product Rule	2.C.4-Equations involving derivatives and vice versa. 2.F.1-Computation of derivatives- Knowledge of derivatives of basic functions, including power, exponential, logarithmic, trigonometric, and inverse trigonomic functions 2.F.2-Basic rules for the derivative of sums, products, and quotients of functions
			Quotient Rule Power Rule Intermediate Value Theorem	
	Velocity and other rates of change	Calculate instantaneous rate of change using rules for differentiation Analyze straight line motion using derivatives Solve problems involving rates of change	Derivatve	2.E.5-Interpretation of the derivative as a rate of change in varied applied contexts, including velocity, speed, and acceleration 2.B.3-Instantaneous rate of change as the limit of average rate of change 2.B.4-Approximate rate of change from graphs and tables of values

Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
			Instantaneous Rate of Change - Tangent line Average Rate of Change - Secant Line Velocity Acceleration				
	Derivatives of Trig Functions	Determine and apply the rules for differentiating the six trig functions					2.A.1-Concept of the derivative-Derivative presented graphically, numerically, and analytically
	Chain Rule	Differentiate composite functions using the chain rule	Chain Rule				2.F.3-Chain rule and implicit differentiation
	Implicit Differentiation	Find derivatives using implicit differentiation	Implicit Differentiation				2.E.4-Use of implicit differentiation to find the derivative of an inverse function 2.F.3-Chain rule and implicit differentiation
	Derivatives of Inverse Trig Functions	Find derivatives of inverse functions Calculate derivatives of inverse trig functions	Inverse Trig Functions: Arcsine Arctangent Arcsecant				2.F.1-Computation of derivatives- Knowledge of derivatives of basic functions, including power, exponential, logarithmic, trigonometric, and inverse trigonomic functions
	Derivatives of Exponential and Logarithmic Functions	Calculate derivatives of logarithmic and exponential functions					2.F.1-Computation of derivatives- Knowledge of derivatives of basic functions, including power, exponential, logarithmic, trigonometric, and inverse trigonomic functions

D Applications of the Derivative

e

Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
c	Extreme Values of Functions	Determine local or global extreme values of functions	Critical Points				2.E.1-Applications of derivatives- Analysis of curves, including the notions of monotonicity and concavity
e							2.E.2-Optimization, both absolute (global) and relative (local) extreme
m							

b			Absolute Extrema	
e				
r				
			Local Extrema	
	Mean Value Theorem	Apply Mean Value Theorem	Mean Value Theorem	2.C.3-The Mean Value Thereon and its geometric consequences
		Find intervals on which a function is increasing or decreasing		2.C.4-Equations involving derivatives and vice versa.
	Connecting derivatives and graphs	Apply the First and Second Derivative tests to determine local extreme values of a function	Increasing Functions	2.C.2-Relationship between the increasing and decreasing behavior of f and the sign of f'
		Determine the concavity of a function and locate points of inflection by analyzing the second derivative		2.D.1-Second derivatives- Corresponding characteristics of the graphs of f, f', and''
		Graph a function using information about the derivatives	Decreasing Functions	2.D.2-Relationship between the concavity of the f and the sign of f''
				2.D.3-Points of inflection as places where concavity changes
			Horizontal Asymptotes	2.E.1-Applications of derivatives- Analysis of curves, including the notions of monotonicity and concavity
			Points of Inflection	
			Concavity	
	Optimization		Primary Equation	2.E.2-Optimization, both absolute (global) and relative (local) extreme
			Secondary Equation	
	Linearizartion and Newton's Method		Local Linearization	2.B.2-Tangent line to a curve at a point and local linear approximation
	Related Rates		Differentiable Functions of Time	2.E.3-Modeling rates of change, including related rates problems

Definite Integral

Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
	Estimating with Finite Sums	Approximate the area under the graph of a nonnegative continuous function by using rectangle approximation methods	Rectangular Approximation Method Left-Ram Right -Ram Mid-Ram Trapezoidal Method				3.F.1-Numerical approximations to definite integrals-Use of Riemann sums (using left, right, and midpoint evaluation points) and trapezoidal sums to approximate definite integrals of functions represented algebraically, graphically, and by tables of values
	Definite Integrals	Interpret the area under a graph as a net accumulation of a rate of change					3.A.1-Interpretation and properties of definite integrals-Definite integral as a limit of Riemann sums
		Express the area under a curve as a definite integral and as a limit of Reimann sums					3.A.2-Definite integral of the rate of change of a quantity over an interval interpreted as the change of the quantity over the interval:a b, f'(x)dx= f(b) -f(a) 3.A.3-Basic properties of definite integrals (examples include additivity and linearity)
	Definite Integrals and Anti-derivatives	Compute the area under a curve using a numerical integration procedure	Average Value of a Function				3.A.1-Interpretation and properties of definite integrals-Definite integral as a limit of Riemann sums
		Apply rules for definite integrals					3.A.2-Definite integral of the rate of change of a quantity over an interval interpreted as the change of the quantity over the interval:a b, f'(x)dx= f(b) -f(a)
		Find the average value of a function over a closed interval					3.A.3-Basic properties of definite integrals (examples include additivity and linearity)
	Fundamental Theorem of Calculus	Apply the Fundamental Theorem of Calculus					3.C.1-Fundamental Theorem of Calculus-Use of the Fundamental Theorem to evaluate definite integrals

Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
		Understand the relationship between the derivative and the definite integral as expressed in the Fundamental Theorem of Calculus					3.C.2-Use of the Fundamental Theorem to represent a particular antiderivative, and the analytical and graphical analysis of functions so defined
	Trapezoidal Rule	Approximate the definite integral by using the Trapezoidal Rule	Trapezoidal Method				3.F.1-Numerical approximations to definite integrals-Use of Riemann sums (using left, right, and midpoint evaluation points) and trapezoidal sums to approximate definite integrals of functions represented algebraically, graphically, and by tables of values

F Differential Equations and Math Modeling

Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
b	Anti-derivatives and Slope Fields	Construct anti-derivatives using the Fundamental Theorem of Calculus	Slope Fields				3.C.2-Use of the Fundamental Theorem to represent a particular antiderivative, and the analytical and graphical analysis of functions so defined
r		Find anti-derivatives of polynomials, exponential and selected trigonometric functions					3.E.2-Solving separable differential equations and using them in modeling (in particular, studying the equation y' = key and exponential growth)
u		Solve initial value problems	Initial Condition				
a		Construct and interpret slope fields					
r							
y	Integration by Substitution	Compute indefinite and definite integrals by substitution	U-Substitution				3.D.1-Techniques of antidifferentiation-Antiderivatives following directly from derivatives of basic functions
		Solve separable differential equations					3.D.2-Antiderivatives by substitution of variables (including change of limits for definite integrals)

Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
	Exponential Growth and Decay	Solve problems involving exponential growth and decay	Separable Differential Equaions				3.E.1-Applications of antidifferentiation-Finding specific antiderivatives using initial conditions, including applications to motion along a line 3.E.2-Solving separable differential equations and using them in modeling (in particular, studying the equation y' = key and exponential growth)
	Population Growth	Solve problems involving exponential or logistic population growth	1st Order Differential Equations Half-Life				3.E.1-Applications of antidifferentiation-Finding specific antiderivatives using initial conditions, including applications to motion along a line 3.E.2-Solving separable differential equations and using them in modeling (in particular, studying the equation y' = key and exponential growth)
			Continuous Compound Interest				

Mar Applications of Definite Integrals

Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
	Integral as Net Change	Solve problems to find the net change by integrating a rate	Area under a curve				3.B.1-Applications of integrals-Whatever applications are chosen, the emphasis is on using the method of setting up an approximating Riemann sum and representing its limits a definite integral. To provide a common foundation, specific applications should include using the integral of a rate of change to give accumulated change, finding the area of a region, the volume of a solid with known cross sections, the average value of a function, and the distance traveled by a particle along a line.

c				3.F.1-Numerical approximations to definite integrals-Use of Riemann sums (using left, right, and midpoint evaluation points) and trapezoidal sums to approximate definite integrals of functions represented algebraically, graphically, and by tables of values
h	Areas in the plane	Calculate areas of regions in a plane using integration	Upper Bound	3.B.1-Applications of integrals-Whatever applications are chosen, the emphasis is on using the method of setting up an approximating Riemann sum and representing its limits a definite integral. To provide a common foundation, specific applications should include using the integral of a rate of change to give accumulated change, finding the area of a region, the volume of a solid with known cross sections, the average value of a function, and the distance traveled by a particle along a line.
	Volumes	Calculate the volumes of solids by slices or shells	Volumes of Revolution:	3.B.1-Applications of integrals-Whatever applications are chosen, the emphasis is on using the method of setting up an approximating Riemann sum and representing its limits a definite integral. To provide a common foundation, specific applications should include using the integral of a rate of change to give accumulated change, finding the area of a region, the volume of a solid with known cross sections, the average value of a function, and the distance traveled by a particle along a line.
	Surface area	Calculate surface area of solids of revolution		
			Washer Method and Shell Method	

	Content	Knowledge and Skills	Vocabulary			Standards
Lengths of curves	Calculate lengths of curves	Arc Length				3.B.1-Applications of integrals-Whatever applications are chosen, the emphasis is on using the method of setting up an approximating Riemann sum and representing its limits a definite integral. To provide a common foundation, specific applications should include using the integral of a rate of change to give accumulated change, finding the area of a region, the volume of a solid with known cross sections, the average value of a function, and the distance traveled by a particle along a line.
Applications from science and statistics	Model problems involving rates of change in a variety of applications					3.B.1-Applications of integrals-Whatever applications are chosen, the emphasis is on using the method of setting up an approximating Riemann sum and representing its limits a definite integral. To provide a common foundation, specific applications should include using the integral of a rate of change to give accumulated change, finding the area of a region, the volume of a solid with known cross sections, the average value of a function, and the distance traveled by a particle along a line.

A
p
r
i
l

Exam Preparation

Essential Questions	Content	Knowledge and Skills	Vocabulary	Assessments	Lessons	Resources	Standards
	Exam Preparation	Exam Preparation					