Trinity Area School District
AP Calculus BC Curriculum Map

Course: AP Calculus BC Grade(s): 12	**Overview of Course** (Briefly describe what students should understand and be able to do as a result of engaging in this course)**:** The purpose of this course is to prepare students for college and for the Advanced Placement exam. Students will explore and solve mathematical problems, think critically, and communicate ideas clearly. Students will evaluate all material presented in class numerically, graphically, and conceptually. This will be done through the use of classroom discussion, small group work, bell ringers, and assigned projects. Students will study algebraic, geometric and graphical concepts of calculus as well as linear, quadratic, exponential and logarithmic functions, series and sequences, polar coordinates, vectors, and trigonometry. Students will learn to evaluate these functions numerically, using the first and second derivative tests, evaluating tables and graphs of derivatives to create functions, and estimating using Euler's Method to name a few. At the completion of the course students will have a comprehensive knowledge of functions, derivatives, integrals, and series and how each topic applies to the conceptual understanding of calculus. Students will represent the basic ideas of calculus through numerical, graphical, algebraic and written formats. Students will be asked to explain the meaning of concepts as well as perform the mathematics represented by the concepts. Students will demonstrate their understanding of the basic ideas of calculus through classroom discussion, written explanations, and constant review of previously presented topics.

Overarching Big Ideas, Enduring Understandings, and Essential Questions
(These "spiral" throughout the entire curriculum.)

Big Idea (A Big Idea is typically a noun and always transferable within and among content areas.)	**Standard(s) Addressed** (What Common Core Standard(s) and/or PA Standard(s) addresses this Big Idea?)	**Enduring Understanding(s)** (SAS refers to Enduring Understandings as "Big Ideas." EUs are the understandings we want students to carry with them after they graduate. EUs will link Big Ideas together. Consider having only one or two EUs per Big Idea.)	**Essential Question(s)** (Essential Questions are broad and open ended. Sometimes, EQs can be debated. A student's answer to an EQ will help teachers determine if he/she truly understands. Consider having only one or two EQs per Enduring Understanding.)
Limits	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CC.2.2.HS.D.1** Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems.	**EU 1.1: The concept of a limit can be used to understand the behavior of functions.** **EU1.2: Continuity is a key property of functions that is defined using limits.**	**EK 1.1C1:** Limits of sums, differences, products, quotients, and composite functions can be found using the basic theorems of limits and algebraic rules. **EK 1.1C2:** The limit of a function may be found by using algebraic manipulation, alternate forms of trigonometric functions, or the squeeze theorem. **EK 1.1C3:** Limits of the indeterminate forms $\frac{0}{0}$ and $\frac{\infty}{\infty}$ may be evaluated using L'Hospital's Rule. **EK 1.1D1:** Asymptotic and unbounded behavior of functions can be explained and described using limits. **EK 1.1D2:** Relative magnitudes of functions and their rates of change can be compared using limits. **EK 1.2A1:** A function f is continuous at $x = c$ provided that $f(c)$ exists, $\lim_{x \to c} f(x)$ exists, and $\lim_{x \to c} f(x) = f(c)$. **EK 1.2A2:** Polynomial, rational, power, exponential, logarithmic, and trigonometric functions are continuous at all points in their domains. **EK 1.2A3:** Types of discontinuities include removable discontinuities, jump discontinuities, and discontinuities due to vertical asymptotes. **EK 1.2B1:** Continuity is an essential condition for theorems such as the Intermediate Value Theorem, the Extreme Value Theorem, and the Mean Value Theorem.

	CC.2.2.HS.D.3 Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4** Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.HS.D.6** Extend the knowledge of rational functions to rewrite in equivalent forms. **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. **C.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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data.		
Derivatives	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.3** Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CC.2.2.HS.D.1** Interpret the structure of expressions to represent a quantity in terms of its context.	**EU 2.1: The derivative of a function is defined as the limit of a difference quotient and can be determined using a variety of strategies.** **EU 2.2: A function's derivative, which is itself a function, can be used to understand the behavior of a function.** **EU 2.3: The derivative has multiple interpretations and applications including those that involve instantaneous rates of change.** **EU 2.4: The Mean Value Theorem connects the behavior of a differentiable function over an interval to the behavior of the derivative of that function at a particular point in the interval.**	**EK 2.1A1:** The difference quotients $\frac{f(a+h)-f(a)}{h}$ and $\frac{f(x)-f(a)}{x-a}$ express the average rate of change of a function over an interval. **EK 2.1A2:** The instantaneous rate of change of a function at a point can be expressed by $\lim_{h\to 0}\frac{f(a+h)-f(a)}{h}$ or $\lim_{x\to a}\frac{f(x)-f(a)}{x-a}$, provided that the limit exists. These are common forms of the definition of the derivative and are denoted $f'(a)$. **EK 2.1A3:** The derivative of f is the function whose value at x is $\lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$ provided this limit exists. **EK 2.1A4:** For $y = f(x)$, notations for the derivative include $\frac{dy}{dx}$, $f'(x)$, and y'. **EK 2.1A5:** The derivative can be represented graphically, numerically, analytically, and verbally. **EK 2.1B1:** The derivative at a point can be estimated from information given in tables or graphs.

	CC.2.2.HS.D.2 Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4** Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.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.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. **C.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**		**EK 2.2A1:** First and second derivatives of a function can provide information about the function and its graph including intervals of increase or decrease, local (relative) and global (absolute) extrema, intervals of upward or downward concavity, and points of inflection. **EK 2.2A2:** Key features of functions and their derivatives can be identified and related to their graphical, numerical, and analytical representations. **EK 2.2A3:** Key features of the graphs of f, f', and f'' are related to one another. **EK 2.2A4: (BC)** For a curve given by a polar equation $r = f(\theta)$, derivatives of r, x, and y with respect to θ and first and second derivatives of y with respect to x can provide information about the curve. **EK 2.2B1:** A continuous function may fail to be differentiable at a point in its domain. **EK 2.2B2:** If a function is differentiable at a point, then it is continuous at that point. **EK 2.3A1:** The unit for $f'(x)$ is the unit for f divided by the unit for x. **EK 2.3A2:** The derivative of a function can be interpreted as the instantaneous rate of change with respect to its independent variable.

	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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.2.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.2.3.HS.A.1** Use geometric figures and their properties to represent transformations in the plane. **CC.2.3.HS.A.2** Apply rigid transformations to determine and explain congruence. **CC.2.3.HS.A.3** Verify and apply geometric theorems as they relate to geometric figures. **CC.2.3.HS.A.4**		

	Apply the concept of congruence to create geometric constructions. **CC.2.3.HS.A.5** Create justifications based on transformations to establish similarity of plane figures. **CC.2.3.HS.A.6** Verify and apply theorems involving similarity as they relate to plane figures. **CC.2.3.HS.A.7** Apply trigonometric ratios to solve problems involving right triangles. **CC.2.3.HS.A.8** Apply geometric theorems to verify properties of circles. **CC.2.3.HS.A.10** Translate between the geometric description and the equation for a conic section. **CC.2.3.HS.A.12** Explain volume formulas and use them to solve problems. **CC.2.3.HS.A.13** Analyze relationships between two-dimensional and three-dimensional objects. **CC.2.3.HS.A.14** Apply geometric concepts to model and solve real world problems. **CC.2.4.HS.B.4** Recognize and evaluate random processes underlying statistical experiments. **CC.2.4.HS.B.5**		

	Make inferences and justify conclusions based on sample surveys, experiments, and observational studies.		
Integrals and the Fundamental Theorem of Calculus	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.3** Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CC.2.2.HS.D.1** Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4** Understand the relationship between zeros and factors of polynomials to make	**EU 3.1 Antidifferentiation is the inverse process of differentiation.** **EU 3.2 The definite integral of a function over an interval is the limit of the Riemann sum over that interval and can be calculated using a variety of strategies.** **EU 3.3 The Fundamental Theorem of Calculus, which has two distinct formulations, connects differentiation and integration.** **EU 3.4 The definite integral of a function over an interval is a mathematical tool with many interpretations and applications involving accumulation.** **EU 3.5 Antidifferentiation is an underlying concept involved in solving separable differential equations. Solving separable differential equations involves determining a function or relation given its rate of change.**	**EK 3.1A1:** An antiderivative of a function f is a function g whose derivative is f. **EK 3.1A2:** Differentiation rules provide the foundation for finding antiderivatives. **EK 3.2A1:** A Riemann sum, which requires a partition of an interval I, is the sum of products, each of which is the value of the function at a point in a subinterval multiplied by the length of that subinterval of the partition. **EK 3.2A2:** The definite integral of a continuous function f over the interval $[a, b]$, denoted by $\int_a^b f(x)dx$, is the limit of Riemann sums as the widths of the subintervals approach 0. That is, $\int_a^b f(x)dx = \lim_{\max \Delta x_i \to 0} \sum_{i=1}^{n} f\left(x_i^*\right)\Delta x_i$ where x_i^* is a value in the ith subinterval, Δx_i is the width of the ith subinterval, n is the number of subintervals, and $\max \Delta x_i$ is the width of the largest subinterval. Another form of the definition is $\int_a^b f(x)dx = \lim_{n \to \infty} \sum_{i=1}^{n} f\left(x_i^*\right)\Delta x_i$, where $\Delta x_i = \frac{b-a}{n}$ and x_i^* is a value in the ith subinterval. **EK 3.2A3:** The information in a definite integral can be translated into the limit of a related Riemann sum, and the limit of a Riemann sum can be written as a definite integral.

	generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.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.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. **C.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**		**EK 3.2B1:** Definite integrals can be approximated for functions that are represented graphically, numerically, algebraically, and verbally. **EK 3.2B2:** Definite integrals can be approximated using a left Riemann sum, a right Riemann sum, a midpoint Riemann sum, or a trapezoidal sum; approximations can be computed using either uniform or nonuniform partitions. **EK 3.2C1:** In some cases, a definite integral can be evaluated by using geometry and the connection between the definite integral and area. **EK 3.2C2:** Properties of definite integrals include the integral of a constant times a function, the integral of the sum of two functions, reversal of limits of integration, and the integral of a function over adjacent intervals. **EK 3.2C3:** The definition of the definite integral may be extended to functions with removable or jump discontinuities. **EK 3.2D1: (BC)** An improper integral is an integral that has one or both limits infinite or has an integrand that is unbounded in the interval of integration. **EK 3.2D2: (BC)** Improper integrals can be determined using limits of definite integrals. **EK 3.3A1:** The definite integral can be used to define new functions; for example, $f(x)=\int_0^x e^{-t^2}\,dt$. **EK 3.3A2:** If f is a continuous function on the interval $[a, b]$, then $\frac{d}{dx}\left(\int_a^x f(t)\,dt\right)=f(x)$, where x is between a and b. **EK 3.3A3:** Graphical, numerical, analytical, and verbal representations of a function f provide information about the function g defined as $g(x)=\int_a^x f(t)\,dt$.

	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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.2.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.2.3.HS.A.1** Use geometric figures and their properties to represent transformations in the plane. G.1.3.1.1, G.1.3.1.2 **CC.2.3.HS.A.2** Apply rigid transformations to determine and explain congruence. G.1.3.1.1, G.1.3.1.2 **CC.2.3.HS.A.3** Verify and apply geometric theorems as they relate to geometric figures. **CC.2.3.HS.A.4** Apply the concept of congruence to create geometric constructions. **CC.2.3.HS.A.5** Create justifications based on transformations to establish similarity of plane figures. **CC.2.3.HS.A.6**		**EK 3.3B1:** The function defined by $F(x)=\int_a^x f(t)dt$ is an antiderivative of f. **EK 3.3B2:** If f is continuous on the interval $[a, b]$ and F is an antiderivative of f, then $\int_a^b f(x)dx = F(b)-F(a)$. **EK 3.3B3:** The notation $\int f(x)dx = F(x)+C$ means that $F'(x)=f(x)$, and $\int f(x)dx$ is called an indefinite integral of the function f. **EK 3.3B4:** Many functions do not have closed form antiderivatives. **EK 3.3B5:** Techniques for finding antiderivatives include algebraic manipulation such as long division and completing the square, substitution of variables, (BC) integration by parts, and nonrepeating linear partial fractions. **EK 3.4A1:** A function defined as an integral represents an accumulation of a rate of change. **EK 3.4A2:** The definite integral of the rate of change of a quantity over an interval gives the net change of that quantity over that interval. **EK 3.4A3:** The limit of an approximating Riemann sum can be interpreted as a definite integral. **EK 3.4B1:** The average value of a function f over an interval $[a, b]$ is $\frac{1}{b-a}\int_a^b f(x)dx$. **EK 3.4C1:** For a particle in rectilinear motion over an interval of time, the definite integral of velocity represents the particle's displacement over the interval of time, and the definite integral of speed represents the particle's total distance traveled over the interval of time. **EK 3.4C2: (BC)** The definite integral can be used to determine displacement, distance, and position of a particle moving along a curve given by parametric or vector-valued functions.

	Verify and apply theorems involving similarity as they relate to plane figures. **CC.2.3.HS.A.7** Apply trigonometric ratios to solve problems involving right triangles. **CC.2.3.HS.A.8** Apply geometric theorems to verify properties of circles. **CC.2.3.HS.A.9** Extend the concept of similarity to determine arc lengths and areas of sectors of circles. **CC.2.3.HS.A.10** Translate between the geometric description and the equation for a conic section. **CC.2.3.HS.A.11** Apply coordinate geometry to prove simple geometric theorems algebraically. **CC.2.3.HS.A.12** Explain volume formulas and use them to solve problems. **CC.2.3.HS.A.13** Analyze relationships between two-dimensional and three-dimensional objects. **CC.2.3.HS.A.14** Apply geometric concepts to model and solve real world problems. **CC.2.4.HS.B.1** Summarize, represent, and interpret data on a single count or measurement variable. **CC.2.4.HS.B.2**		**EK 3.4D1:** Areas of certain regions in the plane can be calculated with definite integrals. (BC) Areas bounded by polar curves can be calculated with definite integrals. **EK 3.4D2:** Volumes of solids with known cross sections, including discs and washers, can be calculated with definite integrals. EK 3.4D3: (BC) The length of a planar curve defined by a function or by a parametrically defined curve can be calculated using a definite integral. **EK 3.4E1:** The definite integral can be used to express information about accumulation and net change in many applied contexts. **EK 3.5A1:** Antidifferentiation can be used to find specific solutions to differential equations with given initial conditions, including applications to motion along a line, exponential growth and decay, (BC) and logistic growth. **EK 3.5A2:** Some differential equations can be solved by separation of variables. **EK 3.5A3:** Solutions to differential equations may be subject to domain restrictions. **EK 3.5A4:** The function F defined by $F(x)=c+\int_a^x f(t)dt$ is a general solution to the differential equation $\frac{dy}{dx}=f(x)$, and $F(x)=y_0+\int_a^x f(t)dt$ is a particular solution to the differential equation $\frac{dy}{dx}=f(x)$ satisfying $F(a)=y_0$. **EK 3.5B1:** The model for exponential growth and decay that arises from the statement "The rate of change of a quantity is proportional to the size of the quantity" is $\frac{dy}{dt}=ky$. EK 3.5B2: (BC) The model for logistic growth that arises from the statement "The rate of change of a quantity is jointly proportional to the size of the quantity and the difference between the quantity and the carrying capacity" is $\frac{dy}{dt}=ky(a-y)$.

	Summarize, represent, and interpret data on two categorical and quantitative variables. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data. **CC.2.4.HS.B.4** Recognize and evaluate random processes underlying statistical experiments. **CC.2.4.HS.B.5** Make inferences and justify conclusions based on sample surveys, experiments, and observational studies. **CC.2.4.HS.B.6** Use the concepts of independence and conditional probability to interpret data. **CC.2.4.HS.B.7** Apply the rules of probability to compute probabilities of compound events in a uniform probability model.		
Series	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.3** Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays. **CC.2.1.HS.F.4**	**EU 4.1 The sum of an infinite number of real numbers may converge.** **EU 4.2 A function can be represented by an associated power series over the interval of convergence for the power series.**	

	Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CC.2.2.HS.D.1** Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4** Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.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.8** Apply inverse operations to solve equations or formulas for a given variable. **CC.2.2.HS.D.9**		**EK 4.1A1:** The *n*th partial sum is defined as the sum of the first *n* terms of a sequence. **EK 4.1A2:** An infinite series of numbers converges to a real number S (or has sum S), if and only if the limit of its sequence of partial sums exists and equals S. **EK 4.1A3:** Common series of numbers include geometric series, the harmonic series, and *p*-series. **EK 4.1A4:** A series may be absolutely convergent, conditionally convergent, or divergent. **EK 4.1A5:** If a series converges absolutely, then it converges. **EK 4.1A6:** In addition to examining the limit of the sequence of partial sums of the series, methods for determining whether a series of numbers converges or diverges are the *n*th term test, the comparison test, the limit comparison test, the integral test, the ratio test, and the alternating series test. **EXCLUSION STATEMENT (EK 4.1A6):** *Other methods for determining convergence or divergence of a series of numbers are not assessed on the AP Calculus AB or BC Exam. However, teachers may include these topics in the course if time permits.* **EK 4.1B1:** If a is a real number and r is a real number such that $\lvert r \rvert < 1$, then the geometric series $\sum_{n=0}^{\infty} ar^n = \frac{a}{1-r}$. **EK 4.1B2:** If an alternating series converges by the alternating series test, then the alternating series error bound can be used to estimate how close a partial sum is to the value of the infinite series. **EK 4.1B3:** If a series converges absolutely, then any series obtained from it by regrouping or rearranging the terms has the same value. **EK 4.2A1:** The coefficient of the *n*th-degree term in a Taylor polynomial centered at $x = a$ for the function f is $\frac{f^{(n)}(a)}{n!}$. **EK 4.2A2:** Taylor polynomials for a function f centered at $x = a$ can be used to approximate function values of f near $x = a$.

	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. **C.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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.2.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.		**EK 4.2A3:** In many cases, as the degree of a Taylor polynomial increases, the *n*th-degree polynomial will converge to the original function over some interval. **EK 4.2A4:** The Lagrange error bound can be used to bound the error of a Taylor polynomial approximation to a function. **EK 4.2A5:** In some situations where the signs of a Taylor polynomial are alternating, the alternating series error bound can be used to bound the error of a Taylor polynomial approximation to the function. **EK 4.2B1:** A power series is a series of the form $\sum_{n=0}^{\infty} a_n(x-r)^n$ where n is a non-negative integer, $\{a_n\}$ is a sequence of real numbers, and r is a real number. **EK 4.2B2:** The Maclaurin series for $\sin(x)$, $\cos(x)$, and e^x provide the foundation for constructing the Maclaurin series for other functions. **EK 4.2B3:** The Maclaurin series for $\frac{1}{1-x}$ is a geometric series. **EK 4.2B4:** A Taylor polynomial for $f(x)$ is a partial sum of the Taylor series for $f(x)$. **EK 4.2B5:** A power series for a given function can be derived by various methods (e.g., algebraic processes, substitutions, using properties of geometric series, and operations on known series such as term-by-term integration or term-by-term differentiation). **EK 4.2C1:** If a power series converges, it either converges at a single point or has an interval of convergence. **EK 4.2C2:** The ratio test can be used to determine the radius of convergence of a power series. **EK 4.2C3:** If a power series has a positive radius of convergence, then the power series is the Taylor series of the function to which it converges over the open interval. **EK 4.2C4:** The radius of convergence of a power series obtained by term-by-term differentiation or term-by-term integration is the same as the radius of convergence of the original power series.

	CC.2.3.HS.A.1 Use geometric figures and their properties to represent transformations in the plane. G.1.3.1.1, G.1.3.1.2 **CC.2.3.HS.A.2** Apply rigid transformations to determine and explain congruence. G.1.3.1.1, G.1.3.1.2 **CC.2.3.HS.A.3** Verify and apply geometric theorems as they relate to geometric figures. **CC.2.3.HS.A.4** Apply the concept of congruence to create geometric constructions. **CC.2.3.HS.A.5** Create justifications based on transformations to establish similarity of plane figures. **CC.2.3.HS.A.6** Verify and apply theorems involving similarity as they relate to plane figures. **CC.2.3.HS.A.7** Apply trigonometric ratios to solve problems involving right triangles. **CC.2.3.HS.A.8** Apply geometric theorems to verify properties of circles. **CC.2.3.HS.A.9** Extend the concept of similarity to determine arc lengths and areas of sectors of circles. **CC.2.3.HS.A.10** Translate between the geometric description and the equation for a conic section. **CC.2.3.HS.A.11** Apply coordinate geometry to prove simple geometric theorems algebraically. **CC.2.3.HS.A.12**		

	Explain volume formulas and use them to solve problems. **CC.2.3.HS.A.13** Analyze relationships between two-dimensional and three-dimensional objects. **CC.2.3.HS.A.14** Apply geometric concepts to model and solve real world problems. **CC.2.4.HS.B.1** Summarize, represent, and interpret data on a single count or measurement variable. **CC.2.4.HS.B.2** Summarize, represent, and interpret data on two categorical and quantitative variables. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data. **CC.2.4.HS.B.4** Recognize and evaluate random processes underlying statistical experiments. **CC.2.4.HS.B.5** Make inferences and justify conclusions based on sample surveys, experiments, and observational studies. **CC.2.4.HS.B.6** Use the concepts of independence and conditional probability to interpret data. **CC.2.4.HS.B.7**		

	Apply the rules of probability to compute probabilities of compound events in a uniform probability model.		

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Month of Instruction (In what month(s) will you teach this unit?)	**Title of Unit**	**Big Idea(s)** (A Big Idea is typically a noun and always transferable within and among content areas.)	**Standard(s) Addressed** (What Common Core Standard(s) and/or PA Standard(s) addresses this Big Idea?)	**Enduring Understanding(s)** (SAS refers to Enduring Understandings as "Big Ideas." EUs are the understandings we want students to carry with them after they graduate. EUs will link Big Ideas together. Consider having only one or two EUs per Big Idea.)	**Essential Question(s)** (Essential Questions are broad and open ended. Sometimes, EQs can be debated. A student's answer to an EQ will help teachers determine if he/she truly understands. Consider having only one or two EQs per Enduring Understanding.)	**Common Resource(s) And Common Assessment(s) Used** (What resources will all teachers of this unit use to help students understand the Big Ideas?)
August	**Limits**	**Limits**	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CC.2.2.HS.D.1** Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2**	**EU 1.1: The concept of a limit can be used to understand the behavior of functions.** **EU1.2: Continuity is a key property of functions that is defined using limits.**	**EK 1.1C1:** Limits of sums, differences, products, quotients, and composite functions can be found using the basic theorems of limits and algebraic rules. **EK 1.1C2:** The limit of a function may be found by using algebraic manipulation, alternate forms of trigonometric functions, or the squeeze theorem. **EK 1.1C3:** Limits of the indeterminate forms $\frac{0}{0}$ and $\frac{\infty}{\infty}$ may be evaluated using L'Hospital's Rule. **EK 1.1D1:** Asymptotic and unbounded behavior of functions can be explained and described using limits. **EK 1.1D2:** Relative magnitudes of functions and their rates of change can be compared using limits. **EK 1.2A1:** A function f is continuous at $x=c$ provided that $f(c)$ exists, $\lim_{x \to c} f(x)$ exists, and $\lim_{x \to c} f(x) = f(c)$. **EK 1.2A2:** Polynomial, rational, power, exponential, logarithmic, and trigonometric functions are continuous at all points in their domains. **EK 1.2A3:** Types of discontinuities include removable discontinuities, jump discontinuities, and discontinuities due to vertical asymptotes. **EK 1.2B1:** Continuity is an essential condition for theorems such as the Intermediate Value Theorem, the Extreme Value Theorem, and the Mean Value Theorem.	Textbook: Calculus Graphical, Numerical, Algebraic by Finney, Demana, Waits, Kennedy; Boston, MA: Pearson, Prentice Hall, 2007 Third AP® Edition TI-84 Emulator Geometer Sketchpad Assessments Notes Homework

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			Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4** Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.HS.D.6** Extend the knowledge of rational functions to rewrite in equivalent forms. **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. **C.2.2.HS.C.1** Use the concept and notation of functions to interpret and apply them in terms of their context.			Activities

			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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data.			

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August-September	**Limits**	**Limits**	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CC.2.2.HS.D.1** Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4** Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5**	**EU 1.1: The concept of a limit can be used to understand the behavior of functions.** **EU1.2: Continuity is a key property of functions that is defined using limits.**	**EK 1.1C1:** Limits of sums, differences, products, quotients, and composite functions can be found using the basic theorems of limits and algebraic rules. **EK 1.1C2:** The limit of a function may be found by using algebraic manipulation, alternate forms of trigonometric functions, or the squeeze theorem. **EK 1.1C3:** Limits of the indeterminate forms $\frac{0}{0}$ and $\frac{\infty}{\infty}$ may be evaluated using L'Hospital's Rule. **EK 1.1D1:** Asymptotic and unbounded behavior of functions can be explained and described using limits. **EK 1.1D2:** Relative magnitudes of functions and their rates of change can be compared using limits. **EK 1.2A1:** A function f is continuous at $x = c$ provided that $f(c)$ exists, $\lim_{x \to c} f(x)$ exists, and $\lim_{x \to c} f(x) = f(c)$. **EK 1.2A2:** Polynomial, rational, power, exponential, logarithmic, and trigonometric functions are continuous at all points in their domains. **EK 1.2A3:** Types of discontinuities include removable discontinuities, jump discontinuities, and discontinuities due to vertical asymptotes. **EK 1.2B1:** Continuity is an essential condition for theorems such as the Intermediate Value Theorem, the Extreme Value Theorem, and the Mean Value Theorem.	• Textbook: Calculus Graphical, Numerical, Algebraic by Finney, Demana, Waits, Kennedy; Boston, MA: Pearson, Prentice Hall, 2007 Third AP® Edition • TI-84 Emulator • Geometer Sketchpad • Assessments • Notes • Homework • Activities

			Use polynomial identities to solve problems. **CC.2.2.HS.D.6** Extend the knowledge of rational functions to rewrite in equivalent forms. **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. **C.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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data.			
September	**Differentiation**	**Derivatives**	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.3** Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	**EU 2.1: The derivative of a function is defined as the limit of a difference quotient and can be determined using a variety of strategies.** **EU 2.2: A function's derivative, which is itself a function, can be used to understand the behavior of a function.** **EU 2.3: The derivative has multiple interpretations and applications including those that involve instantaneous rates of change.**	**EK 2.1A1:** The difference quotients $\frac{f(a+h)-f(a)}{h}$ and $\frac{f(x)-f(a)}{x-a}$ express the average rate of change of a function over an interval. **EK 2.1A2:** The instantaneous rate of change of a function at a point can be expressed by $\lim_{h\to 0}\frac{f(a+h)-f(a)}{h}$ or $\lim_{x\to a}\frac{f(x)-f(a)}{x-a}$, provided that the limit exists. These are common forms of the definition of the derivative and are denoted $f'(a)$. **EK 2.1A3:** The derivative of f is the function whose value at x is $\lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$ provided this limit exists. **EK 2.1A4:** For $y=f(x)$, notations for the derivative include $\frac{dy}{dx}$, $f'(x)$, and y'. **EK 2.1A5:** The derivative can be represented graphically, numerically, analytically, and verbally. **EK 2.1B1:** The derivative at a point can be estimated from information given in tables or graphs.	• Textbook: Calculus Graphical, Numerical, Algebraic by Finney, Demana, Waits, Kennedy; Boston, MA: Pearson, Prentice Hall, 2007 Third AP® Edition • TI-84 Emulator • Geometer Sketchpad • Assessments • Notes

			CC.2.2.HS.D.1 Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4** Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.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.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**	**EU 2.4: The Mean Value Theorem connects the behavior of a differentiable function over an interval to the behavior of the derivative of that function at a particular point in the interval.**	**EK 2.2A1:** First and second derivatives of a function can provide information about the function and its graph including intervals of increase or decrease, local (relative) and global (absolute) extrema, intervals of upward or downward concavity, and points of inflection. **EK 2.2A2:** Key features of functions and their derivatives can be identified and related to their graphical, numerical, and analytical representations. **EK 2.2A3:** Key features of the graphs of f, f', and f'' are related to one another. **EK 2.2A4: (BC)** For a curve given by a polar equation $r = f(\theta)$, derivatives of r, x, and y with respect to θ and first and second derivatives of y with respect to x can provide information about the curve. **EK 2.2B1:** A continuous function may fail to be differentiable at a point in its domain. **EK 2.2B2:** If a function is differentiable at a point, then it is continuous at that point. **EK 2.3A1:** The unit for $f'(x)$ is the unit for f divided by the unit for x. **EK 2.3A2:** The derivative of a function can be interpreted as the instantaneous rate of change with respect to its independent variable.	• Homework • Activities

			Represent, solve, and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically. **C.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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.2.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.2.3.HS.A.1** Use geometric figures and their properties to represent transformations in the plane. **CC.2.3.HS.A.2** Apply rigid transformations to determine and explain congruence. **CC.2.3.HS.A.3** Verify and apply geometric theorems as they relate to geometric figures. **CC.2.3.HS.A.4** Apply the concept of congruence to create geometric constructions. **CC.2.3.HS.A.5** Create justifications based on transformations to establish similarity of plane figures. **CC.2.3.HS.A.6** Verify and apply theorems involving similarity as they relate to plane figures. **CC.2.3.HS.A.7** Apply trigonometric ratios to solve problems involving right triangles. **CC.2.3.HS.A.8** Apply geometric theorems to verify properties of circles. **CC.2.3.HS.A.10**			

			Translate between the geometric description and the equation for a conic section. **CC.2.3.HS.A.12** Explain volume formulas and use them to solve problems. **CC.2.3.HS.A.13** Analyze relationships between two-dimensional and three-dimensional objects. **CC.2.3.HS.A.14** Apply geometric concepts to model and solve real world problems. **CC.2.4.HS.B.4** Recognize and evaluate random processes underlying statistical experiments. **CC.2.4.HS.B.5** Make inferences and justify conclusions based on sample surveys, experiments, and observational studies.			

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October	**Applications of Differentiation**	**Derivatives**	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.3** Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CC.2.2.HS.D.1** Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4**	**EU 2.1: The derivative of a function is defined as the limit of a difference quotient and can be determined using a variety of strategies.** **EU 2.2: A function's derivative, which is itself a function, can be used to understand the behavior of a function.** **EU 2.3: The derivative has multiple interpretations and applications including those that involve instantaneous rates of change.** **EU 2.4: The Mean Value Theorem connects the behavior of a differentiable function over an interval to the behavior of the derivative of that function at a particular point in the interval.**	**EK 2.1A1:** The difference quotients $\frac{f(a+h)-f(a)}{h}$ and $\frac{f(x)-f(a)}{x-a}$ express the average rate of change of a function over an interval. **EK 2.1A2:** The instantaneous rate of change of a function at a point can be expressed by $\lim_{h\to 0}\frac{f(a+h)-f(a)}{h}$ or $\lim_{x\to a}\frac{f(x)-f(a)}{x-a}$, provided that the limit exists. These are common forms of the definition of the derivative and are denoted $f'(a)$. **EK 2.1A3:** The derivative of f is the function whose value at x is $\lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$ provided this limit exists. **EK 2.1A4:** For $y=f(x)$, notations for the derivative include $\frac{dy}{dx}$, $f'(x)$, and y'. **EK 2.1A5:** The derivative can be represented graphically, numerically, analytically, and verbally. **EK 2.1B1:** The derivative at a point can be estimated from information given in tables or graphs.	Textbook: Calculus Graphical, Numerical, Algebraic by Finney, Demana, Waits, Kennedy; Boston, MA: Pearson, Prentice Hall, 2007 Third AP® Edition TI-84 Emulator Geometer Sketchpad Assessments Notes Homework Activities

			Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.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.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. **C.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		**EK 2.2A1:** First and second derivatives of a function can provide information about the function and its graph including intervals of increase or decrease, local (relative) and global (absolute) extrema, intervals of upward or downward concavity, and points of inflection. **EK 2.2A2:** Key features of functions and their derivatives can be identified and related to their graphical, numerical, and analytical representations. **EK 2.2A3:** Key features of the graphs of f, f', and f'' are related to one another. **EK 2.2A4:** (BC) For a curve given by a polar equation $r = f(\theta)$, derivatives of r, x, and y with respect to θ and first and second derivatives of y with respect to x can provide information about the curve. **EK 2.2B1:** A continuous function may fail to be differentiable at a point in its domain. **EK 2.2B2:** If a function is differentiable at a point, then it is continuous at that point. **EK 2.3A1:** The unit for $f'(x)$ is the unit for f divided by the unit for x. **EK 2.3A2:** The derivative of a function can be interpreted as the instantaneous rate of change with respect to its independent variable.	

			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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.2.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.2.3.HS.A.1** Use geometric figures and their properties to represent transformations in the plane. **CC.2.3.HS.A.2** Apply rigid transformations to determine and explain congruence.			

			CC.2.3.HS.A.3 Verify and apply geometric theorems as they relate to geometric figures. **CC.2.3.HS.A.4** Apply the concept of congruence to create geometric constructions. **CC.2.3.HS.A.5** Create justifications based on transformations to establish similarity of plane figures. **CC.2.3.HS.A.6** Verify and apply theorems involving similarity as they relate to plane figures. **CC.2.3.HS.A.7** Apply trigonometric ratios to solve problems involving right triangles. **CC.2.3.HS.A.8** Apply geometric theorems to verify properties of circles. **CC.2.3.HS.A.10** Translate between the geometric description and the equation for a conic section. **CC.2.3.HS.A.12** Explain volume formulas and use them to solve problems. **CC.2.3.HS.A.13** Analyze relationships between two-dimensional and three-dimensional objects.			

			CC.2.3.HS.A.14 Apply geometric concepts to model and solve real world problems. **CC.2.4.HS.B.4** Recognize and evaluate random processes underlying statistical experiments. **CC.2.4.HS.B.5** Make inferences and justify conclusions based on sample surveys, experiments, and observational studies.			
October-November	**Integration**	**Integrals**	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.3** Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	**EU 3.1 Antidifferentiation is the inverse process of differentiation.** **EU 3.2 The definite integral of a function over an interval is the limit of the Riemann sum over that interval and can be calculated using a variety of strategies.** **EU 3.3 The Fundamental Theorem of Calculus, which has two distinct formulations, connects differentiation and integration.**	**EK 3.1A1:** An antiderivative of a function f is a function g whose derivative is f. **EK 3.1A2:** Differentiation rules provide the foundation for finding antiderivatives. **EK 3.2A1:** A Riemann sum, which requires a partition of an interval I, is the sum of products, each of which is the value of the function at a point in a subinterval multiplied by the length of that subinterval of the partition. **EK 3.2A2:** The definite integral of a continuous function f over the interval $[a, b]$, denoted by $\int_a^b f(x)dx$, is the limit of Riemann sums as the widths of the subintervals approach 0. That is, $\int_a^b f(x)dx = \lim_{\max \Delta x_i \to 0} \sum_{i=1}^{n} f(x_i^*)\Delta x_i$ where x_i^* is a value in the ith subinterval, Δx_i is the width of the ith subinterval, n is the number of subintervals, and $\max \Delta x_i$ is the width of the largest subinterval. Another form of the definition is $\int_a^b f(x)dx = \lim_{n\to\infty} \sum_{i=1}^{n} f(x_i^*)\Delta x_i$, where $\Delta x_i = \frac{b-a}{n}$ and x_i^* is a value in the ith subinterval. **EK 3.2A3:** The information in a definite integral can be translated into the limit of a related Riemann sum, and the limit of a Riemann sum can be written as a definite integral.	• Textbook: Calculus Graphical, Numerical, Algebraic by Finney, Demana, Waits, Kennedy; Boston, MA: Pearson, Prentice Hall, 2007 Third AP® Edition • TI-84 Emulator • Geometer Sketchpad • Assessments • Notes • Homework

			CC.2.2.HS.D.1 Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4** Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.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.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.	**EU 3.4 The definite integral of a function over an interval is a mathematical tool with many interpretations and applications involving accumulation.** **EU 3.5 Antidifferentiation is an underlying concept involved in solving separable differential equations. Solving separable differential equations involves determining a function or relation given its rate of change.**	**EK 3.2B1:** Definite integrals can be approximated for functions that are represented graphically, numerically, algebraically, and verbally. **EK 3.2B2:** Definite integrals can be approximated using a left Riemann sum, a right Riemann sum, a midpoint Riemann sum, or a trapezoidal sum; approximations can be computed using either uniform or nonuniform partitions. **EK 3.2C1:** In some cases, a definite integral can be evaluated by using geometry and the connection between the definite integral and area. **EK 3.2C2:** Properties of definite integrals include the integral of a constant times a function, the integral of the sum of two functions, reversal of limits of integration, and the integral of a function over adjacent intervals. **EK 3.2C3:** The definition of the definite integral may be extended to functions with removable or jump discontinuities. **EK 3.2D1: (BC)** An improper integral is an integral that has one or both limits infinite or has an integrand that is unbounded in the interval of integration. **EK 3.2D2: (BC)** Improper integrals can be determined using limits of definite integrals. **EK 3.3A1:** The definite integral can be used to define new functions; for example, $f(x) = \int_0^x e^{-t^2}\,dt$.	• Activities

			CC.2.2.HS.D.10 Represent, solve, and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically. **C.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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.2.HS.C.7** Apply radian measure of an angle and the unit circle to analyze the trigonometric functions. **CC.2.2.HS.C.8**		**EK 3.4D1:** Areas of certain regions in the plane can be calculated with definite integrals. (BC) Areas bounded by polar curves can be calculated with definite integrals. **EK 3.4D2:** Volumes of solids with known cross sections, including discs and washers, can be calculated with definite integrals. EK 3.4D3: (BC) The length of a planar curve defined by a function or by a parametrically defined curve can be calculated using a definite integral. **EK 3.4E1:** The definite integral can be used to express information about accumulation and net change in many applied contexts. **EK 3.5A1:** Antidifferentiation can be used to find specific solutions to differential equations with given initial conditions, including applications to motion along a line, exponential growth and decay, (BC) and logistic growth. **EK 3.5A2:** Some differential equations can be solved by separation of variables. **EK 3.5A3:** Solutions to differential equations may be subject to domain restrictions. **EK 3.5A4:** The function F defined by $F(x)=c+\int_a^x f(t)dt$ is a general solution to the differential equation $\frac{dy}{dx}=f(x)$, and $F(x)=y_0+\int_a^x f(t)dt$ is a particular solution to the differential equation $\frac{dy}{dx}=f(x)$ satisfying $F(a)=y_0$. **EK 3.5B1:** The model for exponential growth and decay that arises from the statement "The rate of change of a quantity is proportional to the size of the quantity" is $\frac{dy}{dt}=ky$. EK 3.5B2: (BC) The model for logistic growth that arises from the statement "The rate of change of a quantity is jointly proportional to the size of the quantity and the difference between the quantity and the carrying capacity" is $\frac{dy}{dt}=ky(a-y)$.	

			Choose trigonometric functions to model periodic phenomena and describe the properties of the graphs. **CC.2.3.HS.A.1** Use geometric figures and their properties to represent transformations in the plane. **CC.2.3.HS.A.2** Apply rigid transformations to determine and explain congruence. **CC.2.3.HS.A.3** Verify and apply geometric theorems as they relate to geometric figures. **CC.2.3.HS.A.4** Apply the concept of congruence to create geometric constructions. **CC.2.3.HS.A.5** Create justifications based on transformations to establish similarity of plane figures. **CC.2.3.HS.A.6** Verify and apply theorems involving similarity as they relate to plane figures. **CC.2.3.HS.A.7** Apply trigonometric ratios to solve problems involving right triangles. **CC.2.3.HS.A.8** Apply geometric theorems to verify properties of circles. **CC.2.3.HS.A.9**			

			Extend the concept of similarity to determine arc lengths and areas of sectors of circles. **CC.2.3.HS.A.10** Translate between the geometric description and the equation for a conic section. **CC.2.3.HS.A.11** Apply coordinate geometry to prove simple geometric theorems algebraically. **CC.2.3.HS.A.12** Explain volume formulas and use them to solve problems. **CC.2.3.HS.A.13** Analyze relationships between two-dimensional and three-dimensional objects. **CC.2.3.HS.A.14** Apply geometric concepts to model and solve real world problems. **CC.2.4.HS.B.1** Summarize, represent, and interpret data on a single count or measurement variable. **CC.2.4.HS.B.2** Summarize, represent, and interpret data on two categorical and quantitative variables. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data.			

			CC.2.4.HS.B.4 Recognize and evaluate random processes underlying statistical experiments. **CC.2.4.HS.B.5** Make inferences and justify conclusions based on sample surveys, experiments, and observational studies. **CC.2.4.HS.B.6** Use the concepts of independence and conditional probability to interpret data. **CC.2.4.HS.B.7** Apply the rules of probability to compute probabilities of compound events in a uniform probability model.			

November -December	**Differential Equations and Modeling**	**Integrals**	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.3** Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CC.2.2.HS.D.1** Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4**	**EU 3.1 Antidifferentiation is the inverse process of differentiation.** **EU 3.2 The definite integral of a function over an interval is the limit of the Riemann sum over that interval and can be calculated using a variety of strategies.** **EU 3.3 The Fundamental Theorem of Calculus, which has two distinct formulations, connects differentiation and integration.** **EU 3.4 The definite integral of a function over an interval is a mathematical tool with many interpretations and applications involving accumulation.** **EU 3.5 Antidifferentiation is an underlying**	**EK 3.1A1:** An antiderivative of a function f is a function g whose derivative is f. **EK 3.1A2:** Differentiation rules provide the foundation for finding antiderivatives. **EK 3.2A1:** A Riemann sum, which requires a partition of an interval I, is the sum of products, each of which is the value of the function at a point in a subinterval multiplied by the length of that subinterval of the partition. **EK 3.2A2:** The definite integral of a continuous function f over the interval $[a, b]$, denoted by $\int_a^b f(x)dx$, is the limit of Riemann sums as the widths of the subintervals approach 0. That is, $\int_a^b f(x)dx = \lim_{\max \Delta x_i \to 0} \sum_{i=1}^{n} f\left(x_i^*\right)\Delta x_i$ where x_i^* is a value in the ith subinterval, Δx_i is the width of the ith subinterval, n is the number of subintervals, and $\max \Delta x_i$ is the width of the largest subinterval. Another form of the definition is $\int_a^b f(x)dx = \lim_{n\to\infty} \sum_{i=1}^{n} f\left(x_i^*\right)\Delta x_i$, where $\Delta x_i = \frac{b-a}{n}$ and x_i^* is a value in the ith subinterval. **EK 3.2A3:** The information in a definite integral can be translated into the limit of a related Riemann sum, and the limit of a Riemann sum can be written as a definite integral.	

			Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.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.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. **C.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	**concept involved in solving separable differential equations. Solving separable differential equations involves determining a function or relation given its rate of change.**	**EK 3.2B1:** Definite integrals can be approximated for functions that are represented graphically, numerically, algebraically, and verbally. **EK 3.2B2:** Definite integrals can be approximated using a left Riemann sum, a right Riemann sum, a midpoint Riemann sum, or a trapezoidal sum; approximations can be computed using either uniform or nonuniform partitions. **EK 3.2C1:** In some cases, a definite integral can be evaluated by using geometry and the connection between the definite integral and area. **EK 3.2C2:** Properties of definite integrals include the integral of a constant times a function, the integral of the sum of two functions, reversal of limits of integration, and the integral of a function over adjacent intervals. **EK 3.2C3:** The definition of the definite integral may be extended to functions with removable or jump discontinuities. **EK 3.2D1: (BC)** An improper integral is an integral that has one or both limits infinite or has an integrand that is unbounded in the interval of integration. **EK 3.2D2: (BC)** Improper integrals can be determined using limits of definite integrals. **EK 3.3A1:** The definite integral can be used to define new functions; for example, $f(x)=\int_0^x e^{-t^2}dt$. **EK 3.3A2:** If f is a continuous function on the interval $[a, b]$, then $\frac{d}{dx}\left(\int_a^x f(t)dt\right)=f(x)$, where x is between a and b. **EK 3.3A3:** Graphical, numerical, analytical, and verbal representations of a function f provide information about the function g defined as $g(x)=\int_a^x f(t)dt$.	

			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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.2.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.2.3.HS.A.1** Use geometric figures and their properties to represent transformations in the plane. **CC.2.3.HS.A.2** Apply rigid transformations to determine and explain congruence. **CC.2.3.HS.A.3**		**EK 3.3B1:** The function defined by $F(x)=\int_a^x f(t)dt$ is an antiderivative of f. **EK 3.3B2:** If f is continuous on the interval $[a, b]$ and F is an antiderivative of f, then $\int_a^b f(x)dx = F(b)-F(a)$. **EK 3.3B3:** The notation $\int f(x)dx = F(x)+C$ means that $F'(x)=f(x)$, and $\int f(x)dx$ is called an indefinite integral of the function f. **EK 3.3B4:** Many functions do not have closed form antiderivatives. **EK 3.3B5:** Techniques for finding antiderivatives include algebraic manipulation such as long division and completing the square, substitution of variables, (BC) integration by parts, and nonrepeating linear partial fractions. **EK 3.4A1:** A function defined as an integral represents an accumulation of a rate of change. **EK 3.4A2:** The definite integral of the rate of change of a quantity over an interval gives the net change of that quantity over that interval. **EK 3.4A3:** The limit of an approximating Riemann sum can be interpreted as a definite integral. **EK 3.4B1:** The average value of a function f over an interval $[a, b]$ is $\frac{1}{b-a}\int_a^b f(x)dx$. **EK 3.4C1:** For a particle in rectilinear motion over an interval of time, the definite integral of velocity represents the particle's displacement over the interval of time, and the definite integral of speed represents the particle's total distance traveled over the interval of time. **EK 3.4C2: (BC)** The definite integral can be used to determine displacement, distance, and position of a particle moving along a curve given by parametric or vector-valued functions.	

			Verify and apply geometric theorems as they relate to geometric figures. **CC.2.3.HS.A.4** Apply the concept of congruence to create geometric constructions. **CC.2.3.HS.A.5** Create justifications based on transformations to establish similarity of plane figures. **CC.2.3.HS.A.6** Verify and apply theorems involving similarity as they relate to plane figures. **CC.2.3.HS.A.7** Apply trigonometric ratios to solve problems involving right triangles. **CC.2.3.HS.A.8** Apply geometric theorems to verify properties of circles. **CC.2.3.HS.A.9** Extend the concept of similarity to determine arc lengths and areas of sectors of circles. **CC.2.3.HS.A.10** Translate between the geometric description and the equation for a conic section. **CC.2.3.HS.A.11** Apply coordinate geometry to prove simple geometric theorems algebraically. **CC.2.3.HS.A.12**		**EK 3.4D1:** Areas of certain regions in the plane can be calculated with definite integrals. (BC) Areas bounded by polar curves can be calculated with definite integrals. **EK 3.4D2:** Volumes of solids with known cross sections, including discs and washers, can be calculated with definite integrals. **EK 3.4D3: (BC)** The length of a planar curve defined by a function or by a parametrically defined curve can be calculated using a definite integral. **EK 3.4E1:** The definite integral can be used to express information about accumulation and net change in many applied contexts. **EK 3.5A1:** Antidifferentiation can be used to find specific solutions to differential equations with given initial conditions, including applications to motion along a line, exponential growth and decay, (BC) and logistic growth. **EK 3.5A2:** Some differential equations can be solved by separation of variables. **EK 3.5A3:** Solutions to differential equations may be subject to domain restrictions. **EK 3.5A4:** The function F defined by $F(x)=c+\int_a^x f(t)dt$ is a general solution to the differential equation $\frac{dy}{dx}=f(x)$, and $F(x)=y_0+\int_a^x f(t)dt$ is a particular solution to the differential equation $\frac{dy}{dx}=f(x)$ satisfying $F(a)=y_0$. **EK 3.5B1:** The model for exponential growth and decay that arises from the statement "The rate of change of a quantity is proportional to the size of the quantity" is $\frac{dy}{dt}=ky$. **EK 3.5B2: (BC)** The model for logistic growth that arises from the statement "The rate of change of a quantity is jointly proportional to the size of the quantity and the difference between the quantity and the carrying capacity" is $\frac{dy}{dt}=ky(a-y)$.	

			Explain volume formulas and use them to solve problems. **CC.2.3.HS.A.13** Analyze relationships between two-dimensional and three-dimensional objects. **CC.2.3.HS.A.14** Apply geometric concepts to model and solve real world problems. **CC.2.4.HS.B.1** Summarize, represent, and interpret data on a single count or measurement variable. **CC.2.4.HS.B.2** Summarize, represent, and interpret data on two categorical and quantitative variables. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data. **CC.2.4.HS.B.4** Recognize and evaluate random processes underlying statistical experiments. **CC.2.4.HS.B.5** Make inferences and justify conclusions based on sample surveys, experiments, and observational studies.			

			CC.2.4.HS.B.6 Use the concepts of independence and conditional probability to interpret data. **CC.2.4.HS.B.7** Apply the rules of probability to compute probabilities of compound events in a uniform probability model.			
December-January	**Applications of Integration**	**Integrals**	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.3** Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CC.2.2.HS.D.1**	**EU 3.1 Antidifferentiation is the inverse process of differentiation.** **EU 3.2 The definite integral of a function over an interval is the limit of the Riemann sum over that interval and can be calculated using a variety of strategies.** **EU 3.3 The Fundamental Theorem of Calculus, which has two distinct formulations, connects differentiation and integration.** **EU 3.4 The definite integral of a function over an interval is a**	**EK 3.1A1:** An antiderivative of a function f is a function g whose derivative is f. **EK 3.1A2:** Differentiation rules provide the foundation for finding antiderivatives. **EK 3.2A1:** A Riemann sum, which requires a partition of an interval I, is the sum of products, each of which is the value of the function at a point in a subinterval multiplied by the length of that subinterval of the partition. **EK 3.2A2:** The definite integral of a continuous function f over the interval $[a, b]$, denoted by $\int_a^b f(x)dx$, is the limit of Riemann sums as the widths of the subintervals approach 0. That is, $\int_a^b f(x)dx = \lim_{\max \Delta x_i \to 0} \sum_{i=1}^{n} f(x_i^*)\Delta x_i$ where x_i^* is a value in the ith subinterval, Δx_i is the width of the ith subinterval, n is the number of subintervals, and $\max \Delta x_i$ is the width of the largest subinterval. Another form of the definition is $\int_a^b f(x)dx = \lim_{n \to \infty} \sum_{i=1}^{n} f(x_i^*)\Delta x_i$, where $\Delta x_i = \frac{b-a}{n}$ and x_i^* is a value in the ith subinterval. **EK 3.2A3:** The information in a definite integral can be translated into the limit of a related Riemann sum, and the limit of a Riemann sum can be written as a definite integral.	• Textbook: Calculus Graphical, Numerical, Algebraic by Finney, Demana, Waits, Kennedy; Boston, MA: Pearson, Prentice Hall, 2007 Third AP® Edition • TI-84 Emulator • Geometer Sketchpad • Assessments • Notes • Homework

			Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4** Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.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.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**	**mathematical tool with many interpretations and applications involving accumulation.** **EU 3.5 Antidifferentiation is an underlying concept involved in solving separable differential equations. Solving separable differential equations involves determining a function or relation given its rate of change.**	**EK 3.2B1:** Definite integrals can be approximated for functions that are represented graphically, numerically, algebraically, and verbally. **EK 3.2B2:** Definite integrals can be approximated using a left Riemann sum, a right Riemann sum, a midpoint Riemann sum, or a trapezoidal sum; approximations can be computed using either uniform or nonuniform partitions. **EK 3.2C1:** In some cases, a definite integral can be evaluated by using geometry and the connection between the definite integral and area. **EK 3.2C2:** Properties of definite integrals include the integral of a constant times a function, the integral of the sum of two functions, reversal of limits of integration, and the integral of a function over adjacent intervals. **EK 3.2C3:** The definition of the definite integral may be extended to functions with removable or jump discontinuities. **EK 3.2D1: (BC)** An improper integral is an integral that has one or both limits infinite or has an integrand that is unbounded in the interval of integration. **EK 3.2D2: (BC)** Improper integrals can be determined using limits of definite integrals. **EK 3.3A1:** The definite integral can be used to define new functions; for example, $f(x)=\int_0^x e^{-t^2}dt$. **EK 3.3A2:** If f is a continuous function on the interval $[a, b]$, then $\frac{d}{dx}\left(\int_a^x f(t)dt\right)=f(x)$, where x is between a and b. **EK 3.3A3:** Graphical, numerical, analytical, and verbal representations of a function f provide information about the function g defined as $g(x)=\int_a^x f(t)dt$.	• Activities

			Represent, solve, and interpret equations/inequalities and systems of equations/inequalities algebraically and graphically. **C.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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.2.HS.C.7** Apply radian measure of an angle and the unit circle to analyze the trigonometric functions. **CC.2.2.HS.C.8**		**EK 3.3B1:** The function defined by $F(x)=\int_a^x f(t)dt$ is an antiderivative of f. **EK 3.3B2:** If f is continuous on the interval $[a, b]$ and F is an antiderivative of f, then $\int_a^b f(x)dx = F(b)-F(a)$. **EK 3.3B3:** The notation $\int f(x)dx = F(x)+C$ means that $F'(x)=f(x)$, and $\int f(x)dx$ is called an indefinite integral of the function f. **EK 3.3B4:** Many functions do not have closed form antiderivatives. **EK 3.3B5:** Techniques for finding antiderivatives include algebraic manipulation such as long division and completing the square, substitution of variables, (BC) integration by parts, and nonrepeating linear partial fractions. **EK 3.4A1:** A function defined as an integral represents an accumulation of a rate of change. **EK 3.4A2:** The definite integral of the rate of change of a quantity over an interval gives the net change of that quantity over that interval. **EK 3.4A3:** The limit of an approximating Riemann sum can be interpreted as a definite integral. **EK 3.4B1:** The average value of a function f over an interval $[a, b]$ is $\frac{1}{b-a}\int_a^b f(x)dx$. **EK 3.4C1:** For a particle in rectilinear motion over an interval of time, the definite integral of velocity represents the particle's displacement over the interval of time, and the definite integral of speed represents the particle's total distance traveled over the interval of time. **EK 3.4C2: (BC)** The definite integral can be used to determine displacement, distance, and position of a particle moving along a curve given by parametric or vector-valued functions.	

			Choose trigonometric functions to model periodic phenomena and describe the properties of the graphs. **CC.2.3.HS.A.1** Use geometric figures and their properties to represent transformations in the plane. **CC.2.3.HS.A.2** Apply rigid transformations to determine and explain congruence. **CC.2.3.HS.A.3** Verify and apply geometric theorems as they relate to geometric figures. **CC.2.3.HS.A.4** Apply the concept of congruence to create geometric constructions. **CC.2.3.HS.A.5** Create justifications based on transformations to establish similarity of plane figures. **CC.2.3.HS.A.6** Verify and apply theorems involving similarity as they relate to plane figures. **CC.2.3.HS.A.7** Apply trigonometric ratios to solve problems involving right triangles. **CC.2.3.HS.A.8** Apply geometric theorems to verify properties of circles. **CC.2.3.HS.A.9**		**EK 3.4D1:** Areas of certain regions in the plane can be calculated with definite integrals. (BC) Areas bounded by polar curves can be calculated with definite integrals. **EK 3.4D2:** Volumes of solids with known cross sections, including discs and washers, can be calculated with definite integrals. **EK 3.4D3: (BC)** The length of a planar curve defined by a function or by a parametrically defined curve can be calculated using a definite integral. **EK 3.4E1:** The definite integral can be used to express information about accumulation and net change in many applied contexts. **EK 3.5A1:** Antidifferentiation can be used to find specific solutions to differential equations with given initial conditions, including applications to motion along a line, exponential growth and decay, (BC) and logistic growth. **EK 3.5A2:** Some differential equations can be solved by separation of variables. **EK 3.5A3:** Solutions to differential equations may be subject to domain restrictions. **EK 3.5A4:** The function F defined by $F(x)=c+\int_a^x f(t)dt$ is a general solution to the differential equation $\frac{dy}{dx}=f(x)$, and $F(x)=y_0+\int_a^x f(t)dt$ is a particular solution to the differential equation $\frac{dy}{dx}=f(x)$ satisfying $F(a)=y_0$. **EK 3.5B1:** The model for exponential growth and decay that arises from the statement "The rate of change of a quantity is proportional to the size of the quantity" is $\frac{dy}{dt}=ky$. **EK 3.5B2: (BC)** The model for logistic growth that arises from the statement "The rate of change of a quantity is jointly proportional to the size of the quantity and the difference between the quantity and the carrying capacity" is $\frac{dy}{dt}=ky(a-y)$.	

			Extend the concept of similarity to determine arc lengths and areas of sectors of circles. **CC.2.3.HS.A.10** Translate between the geometric description and the equation for a conic section. **CC.2.3.HS.A.11** Apply coordinate geometry to prove simple geometric theorems algebraically. **CC.2.3.HS.A.12** Explain volume formulas and use them to solve problems. **CC.2.3.HS.A.13** Analyze relationships between two-dimensional and three-dimensional objects. **CC.2.3.HS.A.14** Apply geometric concepts to model and solve real world problems. **CC.2.4.HS.B.1** Summarize, represent, and interpret data on a single count or measurement variable. **CC.2.4.HS.B.2** Summarize, represent, and interpret data on two categorical and quantitative variables. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data. **CC.2.4.HS.B.4**			

			Recognize and evaluate random processes underlying statistical experiments. **CC.2.4.HS.B.5** Make inferences and justify conclusions based on sample surveys, experiments, and observational studies. **CC.2.4.HS.B.6** Use the concepts of independence and conditional probability to interpret data. **CC.2.4.HS.B.7** Apply the rules of probability to compute probabilities of compound events in a uniform probability model.			

Trinity Area School District
AP Calculus BC Curriculum Map

January	**Parametric and Vector Calculus**	**Derivatives and Integrals**	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.3** Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CC.2.2.HS.D.1** Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4**	**EU 3.1 Antidifferentiation is the inverse process of differentiation.** **EU 3.2 The definite integral of a function over an interval is the limit of the Riemann sum over that interval and can be calculated using a variety of strategies.** **EU 3.3 The Fundamental Theorem of Calculus, which has two distinct formulations, connects differentiation and integration.** **EU 3.4 The definite integral of a function over an interval is a mathematical tool with many interpretations and applications involving accumulation.** **EU 3.5 Antidifferentiation is an underlying**	**EK 2.1A1:** The difference quotients $\frac{f(a+h)-f(a)}{h}$ and $\frac{f(x)-f(a)}{x-a}$ express the average rate of change of a function over an interval. **EK 2.1A2:** The instantaneous rate of change of a function at a point can be expressed by $\lim_{h\to 0}\frac{f(a+h)-f(a)}{h}$ or $\lim_{x\to a}\frac{f(x)-f(a)}{x-a}$, provided that the limit exists. These are common forms of the definition of the derivative and are denoted $f'(a)$. **EK 2.1A3:** The derivative of f is the function whose value at x is $\lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$ provided this limit exists. **EK 2.1A4:** For $y=f(x)$, notations for the derivative include $\frac{dy}{dx}$, $f'(x)$, and y'. **EK 2.1A5:** The derivative can be represented graphically, numerically, analytically, and verbally. **EK 2.1B1:** The derivative at a point can be estimated from information given in tables or graphs.	• Textbook: Calculus Graphical, Numerical, Algebraic by Finney, Demana, Waits, Kennedy; Boston, MA: Pearson, Prentice Hall, 2007 Third AP® Edition • TI-84 Emulator • Geometer Sketchpad • Assessments • Notes • Homework • Activities

			Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.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.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. **C.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	**concept involved in solving separable differential equations. Solving separable differential equations involves determining a function or relation given its rate of change.**	**EK 2.2A1:** First and second derivatives of a function can provide information about the function and its graph including intervals of increase or decrease, local (relative) and global (absolute) extrema, intervals of upward or downward concavity, and points of inflection. **EK 2.2A2:** Key features of functions and their derivatives can be identified and related to their graphical, numerical, and analytical representations. **EK 2.2A3:** Key features of the graphs of f, f', and f'' are related to one another. **EK 2.2A4: (BC)** For a curve given by a polar equation $r = f(\theta)$, derivatives of r, x, and y with respect to θ and first and second derivatives of y with respect to x can provide information about the curve. **EK 2.2B1:** A continuous function may fail to be differentiable at a point in its domain. **EK 2.2B2:** If a function is differentiable at a point, then it is continuous at that point. **EK 2.3A1:** The unit for $f'(x)$ is the unit for f divided by the unit for x. **EK 2.3A2:** The derivative of a function can be interpreted as the instantaneous rate of change with respect to its independent variable.	

			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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.2.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.2.3.HS.A.1** Use geometric figures and their properties to represent transformations in the plane. **CC.2.3.HS.A.2** Apply rigid transformations to determine and explain congruence. **CC.2.3.HS.A.3**		**EK 3.1A1**: An antiderivative of a function f is a function g whose derivative is f. **EK 3.1A2**: Differentiation rules provide the foundation for finding antiderivatives. **EK 3.2A1**: A Riemann sum, which requires a partition of an interval I, is the sum of products, each of which is the value of the function at a point in a subinterval multiplied by the length of that subinterval of the partition. **EK 3.2A2**: The definite integral of a continuous function f over the interval $[a, b]$, denoted by $\int_a^b f(x)dx$, is the limit of Riemann sums as the widths of the subintervals approach 0. That is, $\int_a^b f(x)dx = \lim_{\max \Delta x_i \to 0} \sum_{i=1}^{n} f(x_i^*)\Delta x_i$ where x_i^* is a value in the ith subinterval, Δx_i is the width of the ith subinterval, n is the number of subintervals, and $\max \Delta x_i$ is the width of the largest subinterval. Another form of the definition is $\int_a^b f(x)dx = \lim_{n\to\infty} \sum_{i=1}^{n} f(x_i^*)\Delta x_i$, where $\Delta x_i = \frac{b-a}{n}$ and x_i^* is a value in the ith subinterval. **EK 3.2A3**: The information in a definite integral can be translated into the limit of a related Riemann sum, and the limit of a Riemann sum can be written as a definite integral.	

			Verify and apply geometric theorems as they relate to geometric figures. **CC.2.3.HS.A.4** Apply the concept of congruence to create geometric constructions. **CC.2.3.HS.A.5** Create justifications based on transformations to establish similarity of plane figures. **CC.2.3.HS.A.6** Verify and apply theorems involving similarity as they relate to plane figures. **CC.2.3.HS.A.7** Apply trigonometric ratios to solve problems involving right triangles. **CC.2.3.HS.A.8** Apply geometric theorems to verify properties of circles. **CC.2.3.HS.A.9** Extend the concept of similarity to determine arc lengths and areas of sectors of circles. **CC.2.3.HS.A.10** Translate between the geometric description and the equation for a conic section. **CC.2.3.HS.A.11** Apply coordinate geometry to prove simple geometric theorems algebraically. **CC.2.3.HS.A.12**		**EK 3.2B1:** Definite integrals can be approximated for functions that are represented graphically, numerically, algebraically, and verbally. **EK 3.2B2:** Definite integrals can be approximated using a left Riemann sum, a right Riemann sum, a midpoint Riemann sum, or a trapezoidal sum; approximations can be computed using either uniform or nonuniform partitions. **EK 3.2C1:** In some cases, a definite integral can be evaluated by using geometry and the connection between the definite integral and area. **EK 3.2C2:** Properties of definite integrals include the integral of a constant times a function, the integral of the sum of two functions, reversal of limits of integration, and the integral of a function over adjacent intervals. **EK 3.2C3:** The definition of the definite integral may be extended to functions with removable or jump discontinuities. **EK 3.2D1: (BC)** An improper integral is an integral that has one or both limits infinite or has an integrand that is unbounded in the interval of integration. **EK 3.2D2: (BC)** Improper integrals can be determined using limits of definite integrals. **EK 3.3A1:** The definite integral can be used to define new functions; for example, $f(x)=\int_0^x e^{-t^2}\,dt$. **EK 3.3A2:** If f is a continuous function on the interval $[a, b]$, then $\frac{d}{dx}\left(\int_a^x f(t)dt\right)=f(x)$, where x is between a and b. **EK 3.3A3:** Graphical, numerical, analytical, and verbal representations of a function f provide information about the function g defined as $g(x)=\int_a^x f(t)dt$.	

			Explain volume formulas and use them to solve problems. **CC.2.3.HS.A.13** Analyze relationships between two-dimensional and three-dimensional objects. **CC.2.3.HS.A.14** Apply geometric concepts to model and solve real world problems. **CC.2.4.HS.B.1** Summarize, represent, and interpret data on a single count or measurement variable. **CC.2.4.HS.B.2** Summarize, represent, and interpret data on two categorical and quantitative variables. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data. **CC.2.4.HS.B.4** Recognize and evaluate random processes underlying statistical experiments. **CC.2.4.HS.B.5** Make inferences and justify conclusions based on sample surveys, experiments, and observational studies.		**EK 3.3B1:** The function defined by $F(x)=\int_a^x f(t)dt$ is an antiderivative of f. **EK 3.3B2:** If f is continuous on the interval $[a, b]$ and F is an antiderivative of f, then $\int_a^b f(x)dx = F(b)-F(a)$. **EK 3.3B3:** The notation $\int f(x)dx = F(x)+C$ means that $F'(x)=f(x)$, and $\int f(x)dx$ is called an indefinite integral of the function f. **EK 3.3B4:** Many functions do not have closed form antiderivatives. **EK 3.3B5:** Techniques for finding antiderivatives include algebraic manipulation such as long division and completing the square, substitution of variables, (BC) integration by parts, and nonrepeating linear partial fractions. **EK 3.4A1:** A function defined as an integral represents an accumulation of a rate of change. **EK 3.4A2:** The definite integral of the rate of change of a quantity over an interval gives the net change of that quantity over that interval. **EK 3.4A3:** The limit of an approximating Riemann sum can be interpreted as a definite integral. **EK 3.4B1:** The average value of a function f over an interval $[a, b]$ is $\frac{1}{b-a}\int_a^b f(x)dx$. **EK 3.4C1:** For a particle in rectilinear motion over an interval of time, the definite integral of velocity represents the particle's displacement over the interval of time, and the definite integral of speed represents the particle's total distance traveled over the interval of time. **EK 3.4C2: (BC)** The definite integral can be used to determine displacement, distance, and position of a particle moving along a curve given by parametric or vector-valued functions.	

			CC.2.4.HS.B.6 Use the concepts of independence and conditional probability to interpret data. **CC.2.4.HS.B.7** Apply the rules of probability to compute probabilities of compound events in a uniform probability model.		**EK 3.4D1:** Areas of certain regions in the plane can be calculated with definite integrals. (BC) Areas bounded by polar curves can be calculated with definite integrals. **EK 3.4D2:** Volumes of solids with known cross sections, including discs and washers, can be calculated with definite integrals. **EK 3.4D3: (BC)** The length of a planar curve defined by a function or by a parametrically defined curve can be calculated using a definite integral. **EK 3.4E1:** The definite integral can be used to express information about accumulation and net change in many applied contexts. **EK 3.5A1:** Antidifferentiation can be used to find specific solutions to differential equations with given initial conditions, including applications to motion along a line, exponential growth and decay, (BC) and logistic growth. **EK 3.5A2:** Some differential equations can be solved by separation of variables. **EK 3.5A3:** Solutions to differential equations may be subject to domain restrictions. **EK 3.5A4:** The function F defined by $F(x)=c+\int_a^x f(t)dt$ is a general solution to the differential equation $\frac{dy}{dx}=f(x)$, and $F(x)=y_0+\int_a^x f(t)dt$ is a particular solution to the differential equation $\frac{dy}{dx}=f(x)$ satisfying $F(a)=y_0$. **EK 3.5B1:** The model for exponential growth and decay that arises from the statement "The rate of change of a quantity is proportional to the size of the quantity" is $\frac{dy}{dt}=ky$. **EK 3.5B2: (BC)** The model for logistic growth that arises from the statement "The rate of change of a quantity is jointly proportional to the size of the quantity and the difference between the quantity and the carrying capacity" is $\frac{dy}{dt}=ky(a-y)$.	

Trinity Area School District
AP Calculus BC Curriculum Map

February	**Polar Calculus**	**Derivatives and Integrals**	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.3** Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CC.2.2.HS.D.1** Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4**	**EU 3.1 Antidifferentiation is the inverse process of differentiation.** **EU 3.2 The definite integral of a function over an interval is the limit of the Riemann sum over that interval and can be calculated using a variety of strategies.** **EU 3.3 The Fundamental Theorem of Calculus, which has two distinct formulations, connects differentiation and integration.** **EU 3.4 The definite integral of a function over an interval is a mathematical tool with many interpretations and applications involving accumulation.** **EU 3.5 Antidifferentiation is an underlying**	**EK 2.1A1:** The difference quotients $\frac{f(a+h)-f(a)}{h}$ and $\frac{f(x)-f(a)}{x-a}$ express the average rate of change of a function over an interval. **EK 2.1A2:** The instantaneous rate of change of a function at a point can be expressed by $\lim_{h\to 0}\frac{f(a+h)-f(a)}{h}$ or $\lim_{x\to a}\frac{f(x)-f(a)}{x-a}$, provided that the limit exists. These are common forms of the definition of the derivative and are denoted $f'(a)$. **EK 2.1A3:** The derivative of f is the function whose value at x is $\lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$ provided this limit exists. **EK 2.1A4:** For $y=f(x)$, notations for the derivative include $\frac{dy}{dx}$, $f'(x)$, and y'. **EK 2.1A5:** The derivative can be represented graphically, numerically, analytically, and verbally. **EK 2.1B1:** The derivative at a point can be estimated from information given in tables or graphs.	• Textbook: Calculus Graphical, Numerical, Algebraic by Finney, Demana, Waits, Kennedy; Boston, MA: Pearson, Prentice Hall, 2007 Third AP® Edition • TI-84 Emulator • Geometer Sketchpad • Assessments • Notes • Homework • Activities

			Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.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.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. **C.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	**concept involved in solving separable differential equations. Solving separable differential equations involves determining a function or relation given its rate of change.**	**EK 2.2A1:** First and second derivatives of a function can provide information about the function and its graph including intervals of increase or decrease, local (relative) and global (absolute) extrema, intervals of upward or downward concavity, and points of inflection. **EK 2.2A2:** Key features of functions and their derivatives can be identified and related to their graphical, numerical, and analytical representations. **EK 2.2A3:** Key features of the graphs of f, f', and f'' are related to one another. **EK 2.2A4:** **(BC)** For a curve given by a polar equation $r = f(\theta)$, derivatives of r, x, and y with respect to θ and first and second derivatives of y with respect to x can provide information about the curve. **EK 2.2B1:** A continuous function may fail to be differentiable at a point in its domain. **EK 2.2B2:** If a function is differentiable at a point, then it is continuous at that point. **EK 2.3A1:** The unit for $f'(x)$ is the unit for f divided by the unit for x. **EK 2.3A2:** The derivative of a function can be interpreted as the instantaneous rate of change with respect to its independent variable.	

			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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.2.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.2.3.HS.A.1** Use geometric figures and their properties to represent transformations in the plane. **CC.2.3.HS.A.2** Apply rigid transformations to determine and explain congruence. **CC.2.3.HS.A.3**		**EK 3.1A1**: An antiderivative of a function f is a function g whose derivative is f. **EK 3.1A2**: Differentiation rules provide the foundation for finding antiderivatives. **EK 3.2A1**: A Riemann sum, which requires a partition of an interval I, is the sum of products, each of which is the value of the function at a point in a subinterval multiplied by the length of that subinterval of the partition. **EK 3.2A2**: The definite integral of a continuous function f over the interval $[a, b]$, denoted by $\int_a^b f(x)dx$, is the limit of Riemann sums as the widths of the subintervals approach 0. That is, $\int_a^b f(x)dx = \lim_{\max \Delta x_i \to 0} \sum_{i=1}^{n} f(x_i^*)\Delta x_i$ where x_i^* is a value in the ith subinterval, Δx_i is the width of the ith subinterval, n is the number of subintervals, and $\max \Delta x_i$ is the width of the largest subinterval. Another form of the definition is $\int_a^b f(x)dx = \lim_{n\to\infty} \sum_{i=1}^{n} f(x_i^*)\Delta x_i$, where $\Delta x_i = \frac{b-a}{n}$ and x_i^* is a value in the ith subinterval. **EK 3.2A3**: The information in a definite integral can be translated into the limit of a related Riemann sum, and the limit of a Riemann sum can be written as a definite integral.	

			Verify and apply geometric theorems as they relate to geometric figures. **CC.2.3.HS.A.4** Apply the concept of congruence to create geometric constructions. **CC.2.3.HS.A.5** Create justifications based on transformations to establish similarity of plane figures. **CC.2.3.HS.A.6** Verify and apply theorems involving similarity as they relate to plane figures. **CC.2.3.HS.A.7** Apply trigonometric ratios to solve problems involving right triangles. **CC.2.3.HS.A.8** Apply geometric theorems to verify properties of circles. **CC.2.3.HS.A.9** Extend the concept of similarity to determine arc lengths and areas of sectors of circles. **CC.2.3.HS.A.10** Translate between the geometric description and the equation for a conic section. **CC.2.3.HS.A.11** Apply coordinate geometry to prove simple geometric theorems algebraically. **CC.2.3.HS.A.12**		**EK 3.2B1:** Definite integrals can be approximated for functions that are represented graphically, numerically, algebraically, and verbally. **EK 3.2B2:** Definite integrals can be approximated using a left Riemann sum, a right Riemann sum, a midpoint Riemann sum, or a trapezoidal sum; approximations can be computed using either uniform or nonuniform partitions. **EK 3.2C1:** In some cases, a definite integral can be evaluated by using geometry and the connection between the definite integral and area. **EK 3.2C2:** Properties of definite integrals include the integral of a constant times a function, the integral of the sum of two functions, reversal of limits of integration, and the integral of a function over adjacent intervals. **EK 3.2C3:** The definition of the definite integral may be extended to functions with removable or jump discontinuities. **EK 3.2D1: (BC)** An improper integral is an integral that has one or both limits infinite or has an integrand that is unbounded in the interval of integration. **EK 3.2D2: (BC)** Improper integrals can be determined using limits of definite integrals. **EK 3.3A1:** The definite integral can be used to define new functions; for example, $f(x)=\int_0^x e^{-t^2}dt$. **EK 3.3A2:** If f is a continuous function on the interval $[a, b]$, then $\frac{d}{dx}\left(\int_a^x f(t)dt\right)=f(x)$, where x is between a and b. **EK 3.3A3:** Graphical, numerical, analytical, and verbal representations of a function f provide information about the function g defined as $g(x)=\int_a^x f(t)dt$.	

			Explain volume formulas and use them to solve problems. **CC.2.3.HS.A.13** Analyze relationships between two-dimensional and three-dimensional objects. **CC.2.3.HS.A.14** Apply geometric concepts to model and solve real world problems. **CC.2.4.HS.B.1** Summarize, represent, and interpret data on a single count or measurement variable. **CC.2.4.HS.B.2** Summarize, represent, and interpret data on two categorical and quantitative variables. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data. **CC.2.4.HS.B.4** Recognize and evaluate random processes underlying statistical experiments. **CC.2.4.HS.B.5** Make inferences and justify conclusions based on sample surveys, experiments, and observational studies.		**EK 3.3B1:** The function defined by $F(x)=\int_a^x f(t)dt$ is an antiderivative of f. **EK 3.3B2:** If f is continuous on the interval $[a, b]$ and F is an antiderivative of f, then $\int_a^b f(x)dx = F(b) - F(a)$. **EK 3.3B3:** The notation $\int f(x)dx = F(x)+C$ means that $F'(x)=f(x)$, and $\int f(x)dx$ is called an indefinite integral of the function f. **EK 3.3B4:** Many functions do not have closed form antiderivatives. **EK 3.3B5:** Techniques for finding antiderivatives include algebraic manipulation such as long division and completing the square, substitution of variables, (BC) integration by parts, and nonrepeating linear partial fractions. **EK 3.4A1:** A function defined as an integral represents an accumulation of a rate of change. **EK 3.4A2:** The definite integral of the rate of change of a quantity over an interval gives the net change of that quantity over that interval. **EK 3.4A3:** The limit of an approximating Riemann sum can be interpreted as a definite integral. **EK 3.4B1:** The average value of a function f over an interval $[a, b]$ is $\frac{1}{b-a}\int_a^b f(x)dx$. **EK 3.4C1:** For a particle in rectilinear motion over an interval of time, the definite integral of velocity represents the particle's displacement over the interval of time, and the definite integral of speed represents the particle's total distance traveled over the interval of time. **EK 3.4C2: (BC)** The definite integral can be used to determine displacement, distance, and position of a particle moving along a curve given by parametric or vector-valued functions.	

			CC.2.4.HS.B.6 Use the concepts of independence and conditional probability to interpret data. **CC.2.4.HS.B.7** Apply the rules of probability to compute probabilities of compound events in a uniform probability model.		**EK 3.4D1:** Areas of certain regions in the plane can be calculated with definite integrals. (BC) Areas bounded by polar curves can be calculated with definite integrals. **EK 3.4D2:** Volumes of solids with known cross sections, including discs and washers, can be calculated with definite integrals. **EK 3.4D3: (BC)** The length of a planar curve defined by a function or by a parametrically defined curve can be calculated using a definite integral. **EK 3.4E1:** The definite integral can be used to express information about accumulation and net change in many applied contexts. **EK 3.5A1:** Antidifferentiation can be used to find specific solutions to differential equations with given initial conditions, including applications to motion along a line, exponential growth and decay, (BC) and logistic growth. **EK 3.5A2:** Some differential equations can be solved by separation of variables. **EK 3.5A3:** Solutions to differential equations may be subject to domain restrictions. **EK 3.5A4:** The function F defined by $F(x)=c+\int_a^x f(t)dt$ is a general solution to the differential equation $\frac{dy}{dx}=f(x)$, and $F(x)=y_0+\int_a^x f(t)dt$ is a particular solution to the differential equation $\frac{dy}{dx}=f(x)$ satisfying $F(a)=y_0$. **EK 3.5B1:** The model for exponential growth and decay that arises from the statement "The rate of change of a quantity is proportional to the size of the quantity" is $\frac{dy}{dt}=ky$. **EK 3.5B2: (BC)** The model for logistic growth that arises from the statement "The rate of change of a quantity is jointly proportional to the size of the quantity and the difference between the quantity and the carrying capacity" is $\frac{dy}{dt}=ky(a-y)$.	

March - May	**Sequences and Series (Review for AP Exam)**	**Series**	**CC.2.1.HS.F.1** Apply and extend the properties of exponents to solve problems with rational exponents. **CC.2.1.HS.F.2** Apply properties of rational and irrational numbers to solve real world or mathematical problems. **CC.2.1.HS.F.3** Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays. **CC.2.1.HS.F.4** Use units as a way to understand problems and to guide the solution of multi-step problems. **CC.2.1.HS.F.5** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **CC.2.2.HS.D.1** Interpret the structure of expressions to represent a quantity in terms of its context. **CC.2.2.HS.D.2** Write expressions in equivalent forms to solve problems. **CC.2.2.HS.D.3** Extend the knowledge of arithmetic operations and apply to polynomials. **CC.2.2.HS.D.4**	**EU 4.1 The sum of an infinite number of real numbers may converge.** **EU 4.2 A function can be represented by an associated power series over the interval of convergence for the power series.**	**EK 4.1A1:** The nth partial sum is defined as the sum of the first n terms of a sequence. **EK 4.1A2:** An infinite series of numbers converges to a real number S (or has sum S), if and only if the limit of its sequence of partial sums exists and equals S. **EK 4.1A3:** Common series of numbers include geometric series, the harmonic series, and p-series. **EK 4.1A4:** A series may be absolutely convergent, conditionally convergent, or divergent. **EK 4.1A5:** If a series converges absolutely, then it converges. **EK 4.1A6:** In addition to examining the limit of the sequence of partial sums of the series, methods for determining whether a series of numbers converges or diverges are the nth term test, the comparison test, the limit comparison test, the integral test, the ratio test, and the alternating series test. **EXCLUSION STATEMENT (EK 4.1A6):** *Other methods for determining convergence or divergence of a series of numbers are not assessed on the AP Calculus AB or BC Exam. However, teachers may include these topics in the course if time permits.* **EK 4.1B1:** If a is a real number and r is a real number such that $\|r\| < 1$, then the geometric series $\sum_{n=0}^{\infty} ar^n = \frac{a}{1-r}$. **EK 4.1B2:** If an alternating series converges by the alternating series test, then the alternating series error bound can be used to estimate how close a partial sum is to the value of the infinite series. **EK 4.1B3:** If a series converges absolutely, then any series obtained from it by regrouping or rearranging the terms has the same value. **EK 4.2A1:** The coefficient of the nth-degree term in a Taylor polynomial centered at $x = a$ for the function f is $\frac{f^{(n)}(a)}{n!}$. **EK 4.2A2:** Taylor polynomials for a function f centered at $x = a$ can be used to approximate function values of f near $x = a$.	• Textbook: Calculus Graphical, Numerical, Algebraic by Finney, Demana, Waits, Kennedy; Boston, MA: Pearson, Prentice Hall, 2007 Third AP® Edition • TI-84 Emulator • Geometer Sketchpad • Assessments • Notes • Homework • Activities

			Understand the relationship between zeros and factors of polynomials to make generalizations about functions and their graphs. **CC.2.2.HS.D.5** Use polynomial identities to solve problems. **CC.2.2.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.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. **C.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		**EK 4.2A3:** In many cases, as the degree of a Taylor polynomial increases, the *n*th-degree polynomial will converge to the original function over some interval. **EK 4.2A4:** The Lagrange error bound can be used to bound the error of a Taylor polynomial approximation to a function. **EK 4.2A5:** In some situations where the signs of a Taylor polynomial are alternating, the alternating series error bound can be used to bound the error of a Taylor polynomial approximation to the function. **EK 4.2B1:** A power series is a series of the form $\sum_{n=0}^{\infty} a_n(x-r)^n$ where n is a non-negative integer, $\{a_n\}$ is a sequence of real numbers, and r is a real number. **EK 4.2B2:** The Maclaurin series for $\sin(x)$, $\cos(x)$, and e^x provide the foundation for constructing the Maclaurin series for other functions. **EK 4.2B3:** The Maclaurin series for $\frac{1}{1-x}$ is a geometric series. **EK 4.2B4:** A Taylor polynomial for $f(x)$ is a partial sum of the Taylor series for $f(x)$. **EK 4.2B5:** A power series for a given function can be derived by various methods (e.g., algebraic processes, substitutions, using properties of geometric series, and operations on known series such as term-by-term integration or term-by-term differentiation). **EK 4.2C1:** If a power series converges, it either converges at a single point or has an interval of convergence. **EK 4.2C2:** The ratio test can be used to determine the radius of convergence of a power series. **EK 4.2C3:** If a power series has a positive radius of convergence, then the power series is the Taylor series of the function to which it converges over the open interval. **EK 4.2C4:** The radius of convergence of a power series obtained by term-by-term differentiation or term-by-term integration is the same as the radius of convergence of the original power series.	

			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.2.2.HS.C.6** Interpret functions in terms of the situations they model. **CC.2.2.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.2.3.HS.A.1** Use geometric figures and their properties to represent transformations in the plane. G.1.3.1.1, G.1.3.1.2 **CC.2.3.HS.A.2** Apply rigid transformations to determine and explain congruence. G.1.3.1.1, G.1.3.1.2 **CC.2.3.HS.A.3**			

			Verify and apply geometric theorems as they relate to geometric figures. **CC.2.3.HS.A.4** Apply the concept of congruence to create geometric constructions. **CC.2.3.HS.A.5** Create justifications based on transformations to establish similarity of plane figures. **CC.2.3.HS.A.6** Verify and apply theorems involving similarity as they relate to plane figures. **CC.2.3.HS.A.7** Apply trigonometric ratios to solve problems involving right triangles. **CC.2.3.HS.A.8** Apply geometric theorems to verify properties of circles. **CC.2.3.HS.A.9** Extend the concept of similarity to determine arc lengths and areas of sectors of circles. **CC.2.3.HS.A.10** Translate between the geometric description and the equation for a conic section. **CC.2.3.HS.A.11** Apply coordinate geometry to prove simple geometric theorems algebraically.			

			CC.2.3.HS.A.12 Explain volume formulas and use them to solve problems. **CC.2.3.HS.A.13** Analyze relationships between two-dimensional and three-dimensional objects. **CC.2.3.HS.A.14** Apply geometric concepts to model and solve real world problems. **CC.2.4.HS.B.1** Summarize, represent, and interpret data on a single count or measurement variable. **CC.2.4.HS.B.2** Summarize, represent, and interpret data on two categorical and quantitative variables. **CC.2.4.HS.B.3** Analyze linear models to make interpretations based on the data. **CC.2.4.HS.B.4** Recognize and evaluate random processes underlying statistical experiments. **CC.2.4.HS.B.5** Make inferences and justify conclusions based on sample surveys, experiments, and observational studies.			

			CC.2.4.HS.B.6 Use the concepts of independence and conditional probability to interpret data. **CC.2.4.HS.B.7** Apply the rules of probability to compute probabilities of compound events in a uniform probability model.			