

AP Calculus Unit 1: Intro to Calculus

Lesson	Learning Targets
1.1 Change at an Instant	<ul style="list-style-type: none">• Distinguish between an average and instantaneous rate of change.• Understand why new methods are needed to calculate change at an instant.• Estimate a rate of change at an instant using average rates of change over small intervals surrounding that instant.
1.2 Defining Limits	<ul style="list-style-type: none">• Understand that a limit is the intended value of a function at a particular input and may or may not match the actual value.• Describe limits, including one-sided limits, using proper notation.• Explain why a limit does not exist.
1.3 Analyzing Function Behavior using Limits	<ul style="list-style-type: none">• Describe graph features such as holes and vertical asymptotes using limits.• Rewrite functions in equivalent forms to determine a limit.
1.4 Limits at Infinity	<ul style="list-style-type: none">• Describe the end behavior of a function using limits.• Evaluate limits at infinity by comparing growth rates of numerator and denominator functions.
1.5 Tools for Evaluating Limits Analytically	<ul style="list-style-type: none">• Apply algebraic and trigonometric properties to determine a limit.• Rewrite complex functions as a combination of simpler functions and apply limit properties.
1.6 The Squeeze Theorem	<ul style="list-style-type: none">• Confirm that the conditions of the Squeeze Theorem have been met.• Justify claims about limits using the Squeeze Theorem.
1.7 Continuity and Discontinuity	<ul style="list-style-type: none">• Classify a discontinuity as a removable, jump, or infinite discontinuity.• Justify continuity and discontinuity using the limit definition of continuity.• Identify intervals on which a function is continuous.
1.8 Removing Discontinuities	<ul style="list-style-type: none">• Identify when a discontinuity is removable.• Remove discontinuities by defining or redefining the function value at a point to match the limit value at that point.

	<ul style="list-style-type: none">• Solve for parameters that make a function continuous.
1.9 The Intermediate Value Theorem	<ul style="list-style-type: none">• Confirm that the conditions of the Intermediate Value Theorem (IVT) have been met.• Justify conclusions about a function's guaranteed outputs using the IVT.

AP Calculus Unit 2: Differentiation

Lesson	Learning Targets
2.1 Calculating an Instantaneous Rate of Change	<ul style="list-style-type: none">• Use average rates of change to estimate an instantaneous rate of change.• Evaluate the limit of a difference quotient to calculate the slope at a point.
2.2 The Derivative Function	<ul style="list-style-type: none">• Understand that the derivative of a function is itself a function that outputs the slope of the original curve at any input value.• Use the limit definition of the derivative to calculate a derivative function.• Write the equation of a tangent line.
2.3 Differentiability	<ul style="list-style-type: none">• Estimate derivative values with and without technology.• Justify whether a function is differentiable at a given input value.• Explain the relationship between continuity and differentiability.
2.4 Derivative Patterns	<ul style="list-style-type: none">• Apply the power rule for integer and rational exponents.• Use derivative properties to find derivatives of sums, differences, and constant multiples of functions.
2.5 Derivatives of Sine and Cosine	<ul style="list-style-type: none">• Find derivatives of functions involving sine and cosine.• Recognize expressions involving the definition of the derivative and use derivative shortcuts to evaluate the limits.
2.6 Derivatives of e^x and $\ln x$	<ul style="list-style-type: none">• Find derivatives of functions involving exponential and logarithmic functions.
2.7 The Product Rule	<ul style="list-style-type: none">• Understand why the derivative of a product of two functions f and g depends on f, g, f', and g'.• Use the product rule to find derivatives.
2.8 The Quotient Rule	<ul style="list-style-type: none">• Use the quotient rule to find derivatives.
2.9 Derivatives of Other Trig Functions	<ul style="list-style-type: none">• Develop and apply formulas for the derivatives of tangent, cotangent, secant, and cosecant.

AP Calculus Unit 3: Differentiating Composite, Implicit, and Inverse Functions

Lesson	Learning Targets
3.1 The Chain Rule	<ul style="list-style-type: none">• Understand that in composite functions, the output of one function becomes the input of the next function.• Use the chain rule to find derivatives of composite functions.
3.2 Implicit Differentiation	<ul style="list-style-type: none">• Understand when and why implicit differentiation is needed.• Apply the chain rule to find derivatives of implicitly defined relations.
3.3 Derivatives of Inverse Functions	<ul style="list-style-type: none">• Describe the relationship between slopes at inverse points.• Calculate derivatives of inverse functions.
3.4 Derivatives of Inverse Trig Functions	<ul style="list-style-type: none">• Calculate derivatives of arcsine, arccosine, and arctangent functions.
3.5 Higher-Order Derivatives	<ul style="list-style-type: none">• Recognize and use notation for higher-order derivatives.• Calculate higher-order derivatives.

AP Calculus Unit 4: Contextual Applications of Derivatives

Lesson	Learning Targets
4.1 Interpreting Derivatives in Context	<ul style="list-style-type: none">• Indicate appropriate units for a rate of change.• Interpret a derivative value in context.
4.2 Connecting Position, Velocity, and Acceleration	<ul style="list-style-type: none">• Use first and second derivatives to find the velocity and acceleration of an object, given its position.• Determine when an object is at rest, speeding up, or slowing down.
4.3 Rates of Change in Other Contexts	<ul style="list-style-type: none">• Calculate and interpret derivative values in context.• Use derivatives to make claims about contextual scenarios.• Solve rate-in, rate-out problems.
4.4 Intro to Related Rates	<ul style="list-style-type: none">• Recognize the use of the chain rule in related rate problems.• Solve related rate problems involving spheres, cylinders, and right triangles.
4.5 More Advanced Related Rates	<ul style="list-style-type: none">• Solve related rate problems involving cones.• Interpret and describe scenarios with multiple rates using derivatives.
4.6 Approximating Values with Tangent Lines	<ul style="list-style-type: none">• Use tangent lines to approximate function values near the point of tangency.• Determine if a tangent line approximation is an over- or underestimate.
4.7 L'Hôpital's Rule	<ul style="list-style-type: none">• Evaluate limits of indeterminate form using L'Hôpital's Rule.

AP Calculus Unit 5: Analytical Applications of Derivatives

Lesson	Learning Targets
5.1 The Mean Value Theorem	<ul style="list-style-type: none">• Confirm that the conditions of the Mean Value Theorem (MVT) have been met.• Justify conclusions about a function's rate of change using the MVT.
5.2 Critical Points and Extrema	<ul style="list-style-type: none">• Justify conclusions about a function's extrema using the Extreme Value Theorem.• Distinguish between relative and absolute extrema.• Determine the critical points of a function.
5.3 First Derivative Test	<ul style="list-style-type: none">• Identify intervals on which a function is increasing or decreasing using the function's first derivative.• Justify the location of relative maxima and relative minima using the First Derivative Test.
5.4 Candidates Test	<ul style="list-style-type: none">• Understand that absolute extrema can occur at relative extrema or at endpoints.• Use the Candidate's Test to justify conclusions about a function's absolute extrema in abstract and applied contexts.
5.5 Concavity and the Second Derivative	<ul style="list-style-type: none">• Determine the concavity of a function using the second derivative.• Identify points of inflection.
5.6 Second Derivative Test	<ul style="list-style-type: none">• Use the Second Derivative Test to determine if a critical point is a maximum, minimum, or neither.
5.7 Connecting a Function and Its Derivatives	<ul style="list-style-type: none">• Connect features on the graphs of f, f', and f''.• Use information from a function's first and second derivative to describe the behavior of the original function.
5.8 Optimization	<ul style="list-style-type: none">• Calculate and interpret maximum and minimum values in applied contexts.
5.9 Analyzing Implicit Relations	<ul style="list-style-type: none">• Determine the critical points of an implicit relation.• Use derivatives to justify the behavior of an implicitly defined function.

AP Calculus Unit 6: Integration and Accumulation of Change

Lesson	Learning Targets
6.1 Exploring Accumulation	<ul style="list-style-type: none">• Interpret the meaning of areas under the graph of a rate of change function.• Use common geometric shapes to determine area under a curve.
6.2 Approximation Areas with Rectangles	<ul style="list-style-type: none">• Use left, right, and midpoint Riemann sums to approximate area under a curve.• Determine if a Riemann sum approximation is an overestimate or underestimate.• Approximate accumulations given tabular data with equal and unequal partitions.
6.3 Approximating Areas with Trapezoids	<ul style="list-style-type: none">• Use trapezoidal sums to approximate area under a curve.• Determine if a trapezoidal approximation is an overestimate or underestimate.• Compare and contrast different approximation methods: LRAM, RRAM, MRAM and trapezoidal sums.
6.4 Infinite Riemann Sums and Definite Integrals	<ul style="list-style-type: none">• Understand that a definite integral represents a Riemann sum with infinitely many rectangles of infinitesimal width.• Use a definite integral to represent accumulation of change and the exact area under a curve.
6.5 Accumulation Functions and the FTC	<ul style="list-style-type: none">• Interpret the meaning of the independent and dependent variables of an accumulation function.• Use the Fundamental Theorem of Calculus to find the rate of change of an accumulation function.
6.6 Justifying Behavior of Accumulation Functions	<ul style="list-style-type: none">• Justify the behavior of an accumulation function using information from its derivatives.
6.7 Properties of Definite Integrals	<ul style="list-style-type: none">• Apply integral properties to evaluate definite integrals.
6.8 Evaluating Definite Integrals and the FTC	<ul style="list-style-type: none">• Use the Fundamental Theorem of Calculus to evaluate definite integrals.• Reason about the relationship between derivatives and antiderivatives in context.
6.9 Finding Antiderivatives	<ul style="list-style-type: none">• Find antiderivatives using knowledge of derivatives.• Explain why a constant of integration is needed when evaluating an indefinite integral.• Apply rules for finding antiderivatives.

6.10 U-Substitution	<ul style="list-style-type: none">• Understand that u-substitution is used for integrating chain-rule derivatives.• Evaluate indefinite and definite integrals using u-substitution.
6.11 Other Strategies for Integration	<ul style="list-style-type: none">• Identify when an equivalent form of an integrand is needed to simplify integration.• Evaluate indefinite and definite integrals using long division or completing the square.
6.12 Connecting Riemann Sums with Definite Integrals	<ul style="list-style-type: none">• Use formal notation to express infinite Riemann sums.• Translate between definite integrals and limits of Riemann sums.

AP Calculus Unit 7: Differential Equations

Lesson	Learning Targets
7.1 Intro to Differential Equations	<ul style="list-style-type: none">• Interpret differential equations that describe a context.• Write differential equations based on information about a context's rate of change.• Verify solutions to differential equations.
7.2 Slope Fields	<ul style="list-style-type: none">• Sketch a slope field for a given differential equation.• Reason about particular and general solutions of a differential equation from a slope field.
7.3 General Solutions to Differential Equations	<ul style="list-style-type: none">• Use separation of variables to find general solutions to differential equations.
7.4 Particular Solutions to Differential Equations	<ul style="list-style-type: none">• Use separation of variables with an initial condition to find particular solutions to differential equations.• Write a solution to a differential equation using an integral expression and an initial condition.
7.5 Differential Equations for Exponential Models	<ul style="list-style-type: none">• Identify exponential growth and decay scenarios from a differential equation.• Write solutions to differential equations modeling exponential growth or decay.

AP Calculus Unit 8: Applications of Integration

Lesson	Learning Targets
8.1 Average Value of a Function	<ul style="list-style-type: none"> Interpret the average value of a function geometrically and analytically. Determine the average value of a function using definite integrals. Interpret and write integrals representing average values of functions in context.
8.2 Particle Motion with Integrals	<ul style="list-style-type: none"> Distinguish between total distance and displacement and calculate each. Determine position, velocity, and acceleration using integration and initial conditions.
8.3 Accumulation and Definite Integrals in Other Contexts	<ul style="list-style-type: none"> Use the Fundamental Theorem of Calculus to determine accumulated quantities in context. Solve rate in/rate out problems.
8.4 Area Between Curves in Terms of X	<ul style="list-style-type: none"> Extend knowledge of infinite Riemann sums to regions bounded by two curves. Set up and evaluate integrals to find the area of regions expressed as functions of x.
8.5 Area Between Curves in Terms of Y	<ul style="list-style-type: none"> Understand that a horizontal distance is given by the difference between two x-values. Set up and evaluate integrals to find the area of regions expressed as functions of y.
8.6 Volume With Cross Sections	<ul style="list-style-type: none"> Visualize solids whose cross sections are squares, rectangles, semicircles, and triangles. Set up and evaluate definite integrals that give volumes of solids using known cross sections.
8.7 Volume Using Disks	<ul style="list-style-type: none"> Understand that solids generated by revolving around an axis have circular cross sections that vary in radius. Write expressions for the radius of a disk in terms of x or y. Set up a definite integral to find volume using the disc method.
8.8 Volume Using Washers	<ul style="list-style-type: none"> Determine when solids of revolution are created by subtracting two volumes. Write expressions for the radii of a washer in terms of x or y. Set up a definite integral to find volume using the washer method.