

# Math

## AP CALCULUS

### STANDARD 1

*The student will know, produce, and describe graphs and relations; evaluate and apply limits.*

To meet this standard, the student will:

#### **Benchmark APC.1.1: Analysis of Graphs**

##### **Indicators:**

- APC.1.1.1 Produce graphs with the aid of technology
- APC.1.1.2 Predict and explain the observed local and global behavior of a function using interplay of geometric and analytic information and on the use of calculus

#### **Benchmark APC.1.2: Limits of Functions (including one-sided limits)**

##### **Indicators:**

- APC.1.2.1 Demonstrate an intuitive understanding of the limiting process
- APC.1.2.2 Calculate limits using algebra
- APC.1.2.3 Estimate limits from graphs or tables of data

#### **Benchmark APC.1.3: Asymptotic and Unbounded Behavior**

##### **Indicators:**

- APC.1.3.1 Understand asymptotes in terms of graphical behavior
- APC.1.3.2 Describe asymptotic behavior in terms of limits involving infinity
- APC.1.3.3 Compare relative magnitudes of functions and their rates of change. (For example: contrasting exponential growth, polynomial growth, and logarithmic growth.)

#### **Benchmark APC.1.4: Continuity as a Property of Functions**

##### **Indicators:**

- APC.1.4.1 Demonstrate an intuitive understanding of continuity. (Close values of the domain lead to close values of the range.)
- APC.1.4.2 Understand continuity in terms of limits
- APC.1.4.3 Demonstrate geometric understanding of graphs of continuous functions (Intermediate Value Theorem and Extreme Value Theorem).

*Key: 1. Discipline 1.1 Standard 1.1.1 Benchmark 1.1.1.1 Indicator*

*SCS Curriculum, Math, AP Calculus, approved Jan. 15, 2007*

# Math

## AP CALCULUS

### STANDARD 2

The student will *understand and apply what the derivative represents graphically, numerically, and analytically; determine, graph, interpret, and apply derivatives.*

To meet this standard, the student will:

#### **Benchmark APC.2.1: Concept of the Derivative**

##### **Indicators:**

- APC.2.1.1 Present the derivative geometrically, numerically, and analytically
- APC.2.1.2 Interpret the derivative as an instantaneous rate of change
- APC.2.1.3 Define the derivative as the limit of the difference quotient
- APC.2.1.4 Describe the relationship between differentiability and continuity

#### **Benchmark APC.2.2: Derivative at a Point**

##### **Indicators:**

- APC.2.2.1 Determine the slope of a curve at a point (including vertical tangents and points at which there are no tangents)
- APC.2.2.2 Determine the tangent line to a curve at a point and local linear approximation
- APC.2.2.3 Express and evaluate the instantaneous rate of change as the limit of average rate of change
- APC.2.2.4 Approximate the rate of change from graphs and tables of values.

#### **Benchmark APC.2.3: Derivative as a Function**

##### **Indicators:**

- APC.2.3.1 Understand and apply corresponding characteristics of graphs of  $f$  and  $f'$
- APC.2.3.2 Demonstrate the relationship between the increasing and decreasing behavior of  $f$  and  $f'$
- APC.2.3.3 Understand the Mean Value Theorem and its geometric consequences
- APC.2.3.4 Solve equations involving derivatives (Translate verbal descriptions into equations involving derivatives and vice versa)

Key: 1. Discipline 1.1 Standard 1.1.1 Benchmark 1.1.1.1 Indicator

SCS Curriculum, Math, AP Calculus, approved Jan. 15, 2007

### **Benchmark APC.2.4: Second Derivative**

#### **Indicators:**

- APC.2.4.1 Understand and apply corresponding characteristics of the graphs of  $f$ ,  $f'$ , and  $f''$
- APC.2.4.2 Determine and graphically display the concavity of  $f$  based the sign of  $f''$
- APC.2.4.3 Identify points of inflection as places where concavity changes.
- APC.2.4.5 Solve and/or pose problems related to an experiment, using the findings of the experiment

### **Benchmark APC.2.5: Applications of Derivatives**

#### **Indicators:**

- APC.2.5.1 Analyze curves, including the notions of monotonicity and concavity
- APC.2.5.2 Determine optimizations, both absolute (global) and relative (local) extrema
- APC.2.5.3 Model rates of change, including related rates problems
- APC.2.5.4 Use implicit differentiation to find the derivative of an inverse function
- APC.2.5.5 Interpret a derivative as a rate of change in varied applied contexts, including velocity, speed and acceleration

### **Benchmark APC.2.6: Computation of Derivatives**

#### **Indicators:**

- APC.2.6.1 Know the derivatives of basic functions, including power, exponential, trigonometric, and inverse trigonometric functions
- APC.2.6.2 Apply basic rules for the derivative of sums, products, and quotients of functions
- APC.2.6.3 Apply the chain rule and implicit differentiation to various equations and situations.

*Key: 1. Discipline 1.1 Standard 1.1.1 Benchmark 1.1.1.1 Indicator*

*SCS Curriculum, Math, AP Calculus, approved Jan. 15, 2007*

# Math

## AP CALCULUS

### STANDARD 3

*The student will understand and apply what the integral represents graphically, numerically, and analytically; determine, interpret, and apply integrals.*

To meet this standard, the student will:

#### **Benchmark APC.3.1: Interpretations and properties of definite integrals**

##### **Indicators:**

- APC.3.1.1 Use trapezoid sums to approximate definite integrals of functions represented algebraically, geometrically, and by tables of values
- APC.3.1.2 Compute Riemann sums using left, right and midpoint evaluation points
- APC.3.1.3 Evaluate the definite integral as a limit of Riemann sums over equal subdivisions
- APC.3.1.4 Evaluate the definite integral of the rate of change of a quantity over an interval interpreted as the change of the quantity over the interval:

$$\int_a^b f'(x)dx = f(b) - f(a) .$$

- APC.3.1.5 Know basic properties of definite integrals. (Examples include additivity and linearity.)

#### **Benchmark APC.3.2: Applications of intervals**

##### **Indicators:**

- APC.3.2.1 Use appropriate integrals in a variety of applications to model physical, social, or economic situations
- APC.3.2.2 Apply the integral as a rate of change to give accumulated change
- APC.3.2.3 Apply the integral by setting up an approximating Riemann sum and representing its limit as a definite integral
- APC.3.2.4 Find the area of a region, the volume of a solid with known cross sections, the average value of a function, and the distance traveled by a particle along a line

#### **Benchmark APC.3.3: Fundamental theorem of calculus**

##### **Indicators:**

- APC.3.3.1 Use the Fundamental Theorem to evaluate definite integrals
- APC.3.3.2 Use the Fundamental Theorem to represent a particular antiderivative, and the analytical and graphical analysis of functions so defined

Key: 1. Discipline 1.1 Standard 1.1.1 Benchmark 1.1.1.1 Indicator

SCS Curriculum, Math, AP Calculus, approved Jan. 15, 2007

**Benchmark APC.3.4: Techniques of antidifferentiation**

**Indicators:**

- APC.3.4.1 Find antiderivatives following directly from derivatives of basic functions
- APC.3.4.2 Find antiderivatives by substitution of variables (including change of limits for definite integrals)

**Benchmark APC.3.5: Applications of antidifferentiation**

**Indicators:**

- APC.3.5.1 Find specific antiderivatives using initial conditions, including applications to motion along a line
- APC.3.5.2 Solve separable differential equations and use them in modeling. In particular, study the equation  $y' = ky$  and exponential growth