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AP Calc AB: Derivatives

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## Notation

There are many ways to denote the derivative of a function  $y = f(x)$ . Besides  $f'(x)$ , the most common notations are these:

$y'$	“y prime”	Nice and brief, but does not name the independent variable.
$\frac{dy}{dx}$	“dy dx” or “the derivative of y with respect to x”	Names both variables and uses $d$ for derivative.
$\frac{df}{dx}$	“df dx” or “the derivative of $f$ with respect to $x$ ”	Emphasizes the function’s name.
$\frac{d}{dx}f(x)$	“d dx of $f$ at $x$ ” or “the derivative of $f$ at $x$ ”	Emphasizes the idea that differentiation is an operation performed on $f$ .

### RULE 1 Derivative of a Constant Function

If  $f$  is the function with the constant value  $c$ , then

$$\frac{df}{dx} = \frac{d}{dx}(c) = 0.$$

### RULE 2 Power Rule for Positive Integer Powers of $x$

If  $n$  is a positive integer, then

$$\frac{d}{dx}(x^n) = nx^{n-1}.$$

If  $n$  is a negative integer and  $x \neq 0$ , then

$$\frac{d}{dx}(x^n) = nx^{n-1}.$$

### RULE 3 The Constant Multiple Rule

If  $u$  is a differentiable function of  $x$  and  $c$  is a constant, then

$$\frac{d}{dx}(cu) = c \frac{du}{dx}.$$

### RULE 4 The Sum and Difference Rule

If  $u$  and  $v$  are differentiable functions of  $x$ , then their sum and difference are differentiable at every point where  $u$  and  $v$  are differentiable. At such points,

$$\frac{d}{dx}(u \pm v) = \frac{du}{dx} \pm \frac{dv}{dx}.$$

In function notation,

$$(f + g)' = f' + g' \quad (f - g)' = f' - g'$$

**Examples:**

1. Find  $\frac{dp}{dt}$  if  $p = t^3 + 6t^2 - \frac{5}{3}t + 16$

2. Find  $\frac{dy}{dx}$  if  $y = -x^2 + 3$

3. Find  $\frac{dy}{dx}$  if  $y = \frac{x^3}{3} - 3$

4. Find  $\frac{dy}{dx}$  if  $y = x^2 + x + 1$

5. Find  $\frac{dy}{dx}$  if  $y = x^4 - 7x^3 + 2x^2 + 15$

6. Find  $\frac{dy}{dx}$  if  $y = 4x^{-2} - 8x + 1$

7. Find  $\frac{dy}{dx}$  if  $y = \frac{x^{-4}}{4} - \frac{x^{-3}}{3} + \frac{x^{-2}}{2} - x^{-1} + 3$

8. Use the definition of derivative to show that  $\frac{d}{dx}(x) = 1$ .