

# Chapter 2

## Derivatives

### 2.3 Differentiation Formulas

## Constant Function.

### Derivative of a Constant Function

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

## Power Functions.

$n = 1.$

$n = 2.$

$n = 3.$

**The Power Rule** If  $n$  is a positive integer, then

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

## Derivatives rules: Constant multiple, Sum and Difference

**EXAMPLE 4** Find the points on the curve  $y = x^4 - 6x^2 + 4$  where the tangent line is horizontal.

### Multiplication by a constant.

**The Constant Multiple Rule** If  $c$  is a constant and  $f$  is a differentiable function, then

$$\frac{d}{dx}[cf(x)] = c \frac{d}{dx}f(x)$$

### Sum.

**The Sum Rule** If  $f$  and  $g$  are both differentiable, then

$$\frac{d}{dx}[f(x) + g(x)] = \frac{d}{dx}f(x) + \frac{d}{dx}g(x)$$

### Difference.

**The Difference Rule** If  $f$  and  $g$  are both differentiable, then

$$\frac{d}{dx}[f(x) - g(x)] = \frac{d}{dx}f(x) - \frac{d}{dx}g(x)$$

## Product.

**The Product Rule** If  $f$  and  $g$  are both differentiable, then

$$\frac{d}{dx}[f(x)g(x)] = f(x) \frac{d}{dx}[g(x)] + g(x) \frac{d}{dx}[f(x)]$$

Caution!!!

$$\frac{d}{dx}(fg) \neq \frac{d}{dx}(f) \frac{d}{dx}(g).$$

Example.



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**Example.** Find the derivative of the function  $f(x) = (5x^2 - 2)(x^3 + 3x)$ .

## Quotient.

**The Quotient Rule** If  $f$  and  $g$  are differentiable, then

$$\frac{d}{dx} \left[ \frac{f(x)}{g(x)} \right] = \frac{g(x) \frac{d}{dx} [f(x)] - f(x) \frac{d}{dx} [g(x)]}{[g(x)]^2}$$

**Caution !!**

$$\frac{d}{dx} \left( \frac{f}{g} \right) \neq \frac{\frac{d}{dx}(f)}{\frac{d}{dx}(g)}$$

**Example.**



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**EXAMPLE 8** Let  $y = \frac{x^2 + x - 2}{x^3 + 6}$ . Compute the derivative.

## General Power rule.

**The Power Rule (General Version)** If  $n$  is any real number, then

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

Case  $n = 0$ :

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**Example.** Find the derivative of the function  $f(x) = x^{2/3}$ .

**EXAMPLE 13** At what points on the hyperbola  $xy = 12$  is the tangent line parallel to the line  $3x + y = 0$ ?

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Summary of Differentiation Formulas.

**Table of Differentiation Formulas**

$\frac{d}{dx}(c) = 0$	$\frac{d}{dx}(x^n) = nx^{n-1}$	
$(cf)' = cf'$	$(f + g)' = f' + g'$	$(f - g)' = f' - g'$
$(fg)' = fg' + gf'$	$\left(\frac{f}{g}\right)' = \frac{gf' - fg'}{g^2}$	