

## The Chain Rule

1.7

### OBJECTIVE

- Find the composition of two functions.
- Differentiate using the Extended Power Rule or the Chain Rule.

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## 1.7 The Chain Rule

### THEOREM 7: The Chain Rule

The derivative of the composition  $f \circ g$  is given by

$$\frac{d}{dx} (f \circ g)(x) = \frac{d}{dx} f(g(x)) = f'(g(x)) \cdot g'(x)$$

The derivative of the outside function times the derivative of the inside function

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## 1.7 The Chain Rule

### THEOREM 8: The Extended Power Rule

Suppose that  $g(x)$  is a differentiable function of  $x$ . Then, for any real number  $k$ ,

$$\frac{d}{dx} [g(x)]^k = k[g(x)]^{k-1} \cdot \frac{d}{dx} g(x)$$

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## 1.7 The Chain Rule

**Example 1:** Differentiate  $f(x) = 3x^4 + x^2 - 9$ <sup>100</sup>.

$$\begin{aligned} \frac{d}{dx} (3x^4 + x^2 - 9)^{100} &= 100 (3x^4 + x^2 - 9)^{99} (12x^3 + 2x) \\ &= 200x (3x^4 + x^2 - 9)^{99} (6x^2 + 1) \end{aligned}$$

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## 1.7 The Chain Rule

**Example 2:** Differentiate  $f(x) = 1 + x^3$ .

$$\begin{aligned}\frac{d}{dx} (1 + x^3)^{\frac{1}{2}} &= \frac{1}{2} (1 + x^3)^{\frac{1}{2}-1} \cdot 3x^2 \\ &= \frac{3x^2}{2} (1 + x^3)^{-\frac{1}{2}} \\ &= \frac{3x^2}{2\sqrt{1+x^3}}\end{aligned}$$