

23.9 Higher Derivatives

$$y = f(x)$$

$$f'(x) = y' = \frac{dy}{dx} \quad \text{1st Derivative}$$

$$f''(x) = y'' = \frac{d^2y}{dx^2} \quad \text{2nd Derivative} \quad (\text{Derivative of the 1st Derivative})$$

$$f'''(x) = y''' = \frac{d^3y}{dx^3} \quad \text{3rd Derivative} \quad (\text{" " " 2nd " })$$

⋮

$$f^{(n)}(x) = y^{(n)} \quad n^{\text{th}} \text{ Derivative}$$

$$f^{(n)}(x) = y^{(n)}$$

⋮

p. 686
⑫

$$y = 6x - 2x^5$$

$$y' = 6 - 2(5x^4) = 6 - 10x^4$$

$$y'' = 0 - 10(4x^3) = -40x^3$$

④ $f(x) = 3x - x^4$

$$f'(x) = 3 - 4x^3$$

$$f''(x) = 0 - 4(3x^2) = -12x^2$$

$$f'''(x) = -24x$$

$$f^{(4)}(x) = -24$$

$$f^{(5)}(x) = 0$$

$$f^{(n)}(x) = 0 \quad \text{when } n \geq 5$$

$$\textcircled{16} \quad f(x) = \sqrt[3]{6x+5} = (6x+5)^{1/3}$$

$$f'(x) = \frac{1}{3}(6x+5)^{-2/3} (6) = 2(6x+5)^{-2/3}$$

$$f''(x) = 2\left(-\frac{2}{3}\right)(6x+5)^{-2/3-1} (6) = -8(6x+5)^{-5/3}$$

$$\textcircled{22} \quad y = 3(2x^3 + 3)^4$$

$$y' = 3 \cdot 4(2x^3+3)^3 (6x^2) = \overbrace{72x^2}^F \overbrace{(2x^3+3)^3}^S$$

$$y'' = \overbrace{72x^2}^F \cdot \overbrace{3(2x^3+3)^2}^{S'} (6x^2) + \overbrace{(2x^3+3)^3}^S \cdot \overbrace{144x}^{F'}$$

$$y'' = 1296x^4(2x^3+3)^2 + 144x(2x^3+3)^3$$

$$\textcircled{24} \quad f(R) = \frac{1-3R \leftarrow T}{1+3R \leftarrow B}$$

$$f'(R) = \frac{\overbrace{(1+3R)}^B \overbrace{(-3)}^{T'} - \overbrace{(1-3R)}^T \overbrace{(3)}^{B'}}{\underbrace{(1+3R)^2}_{B^2 S}} = \frac{-3 - 9R - 3 + 9R}{(1+3R)^2} = \frac{-6}{(1+3R)^2} = -6(1+3R)^{-2}$$

$$f''(R) = -6(-2)(1+3R)^{-2-1} (3) = 36(1+3R)^{-3} \text{ or } \frac{36}{(1+3R)^3}$$

s = displacement or distance with respect to time, t .
 $V = \frac{ds}{dt}$ is instantaneous velocity with respect to time.

$a = \frac{d^2s}{dt^2}$ is acceleration with respect to time.

(44) $s = 57.6t - 1.20t^3$

$$V = s' = 57.6 - 1.20(3t^2) = 57.6 - 3.60t^2$$

$$v(4) = 57.6 - 3.60(4)^2 = 0 \text{ ft/s} \leftarrow \text{car is stopped.}$$

$$a = s'' = -7.20t$$

$$a(4) = -7.20(4) = -28.8 \text{ ft/s}^2 \leftarrow \text{deceleration}$$

p. 686-687: 5, 11, 13, 15, 21, 25, 37, 43, 47