

## 3.5 examples

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### 3.5 examples

## Calculus AB, sect. 3.5 – Higher Derivatives

### Example 1

Find  $f''(x)$  and  $f'''(x)$  for  $f(x) = x^4 + 2x - 9x^{-2}$  and evaluate  $f'''(-1)$ .

$$f'(x) = 4x^3 + 2 + 18x^{-3}$$

$$f''(x) = 12x^2 - 54x^{-4}$$

$$f'''(x) = 24x + 216x^{-5}$$

$$f'''(-1) = -24 - 216 = -240$$

## Example 2

Calculate the first four derivatives of  $y = x^{-1}$ . Then find the pattern and determine a general formula for the  $n$ th derivative  $y^{(n)}$ .

$$y' = -x^{-2}$$

$$y'' = 2x^{-3}$$

$$y^{(3)} = -6x^{-4}$$

$$y^{(4)} = 24x^{-5}$$

$$y^{(n)}(x) = (-1)^n n! x^{-(n+1)}$$

### Example 3

Calculate  $f'''(x)$  for  $f(x) = xe^x$

$$f'(x) = e^x + xe^x$$

$$f''(x) = e^x + (e^x + xe^x) = 2e^x + xe^x$$

$$f'''(x) = e^x + e^x + (e^x + xe^x) = 3e^x + xe^x$$

$$f^{(n)}(x) = ne^x + xe^x$$

$$165: 12, 14, 33, 37, 39, 40, 41, 45$$

Example 4 – Acceleration due to Gravity

Calculate the acceleration  $a(t)$  of a ball tossed vertically in the air from ground level with an initial velocity of 40 ft/s. How does  $a(t)$  describe the change in the ball's velocity as it rises and falls?