

Differentiation - Natural Logs and Exponentials

Date_____ Period_____

Differentiate each function with respect to x .

1) $y = \ln x^3$

2) $y = e^{2x^3}$

3) $y = \ln \ln 2x^4$

4) $y = \ln \ln 3x^3$

5) $y = \cos \ln 4x^3$

6) $y = e^{e^{3x^2}}$

7) $y = e^{(4x^3 + 5)^2}$

8) $y = \ln 4x^2 \cdot (-x^3 - 4)$

9) $y = \ln \left(-\frac{4x^4}{x^3 - 3} \right)^5$

10) $y = \frac{e^{5x^4}}{e^{4x^2 + 3}}$

Differentiation - Natural Logs and Exponentials

Differentiate each function with respect to x .

1) $y = \ln x^3$

$$\begin{aligned}\frac{dy}{dx} &= \frac{1}{x^3} \cdot 3x^2 \\ &= \frac{3}{x}\end{aligned}$$

2) $y = e^{2x^3}$

$$\frac{dy}{dx} = e^{2x^3} \cdot 6x^2$$

3) $y = \ln \ln 2x^4$

$$\begin{aligned}\frac{dy}{dx} &= \frac{1}{\ln 2x^4} \cdot \frac{1}{2x^4} \cdot 8x^3 \\ &= \frac{4}{x \ln 2x^4}\end{aligned}$$

4) $y = \ln \ln 3x^3$

$$\begin{aligned}\frac{dy}{dx} &= \frac{1}{\ln 3x^3} \cdot \frac{1}{3x^3} \cdot 9x^2 \\ &= \frac{3}{x \ln 3x^3}\end{aligned}$$

5) $y = \cos \ln 4x^3$

$$\begin{aligned}\frac{dy}{dx} &= -\sin \ln 4x^3 \cdot \frac{1}{4x^3} \cdot 12x^2 \\ &= -\frac{3 \sin \ln 4x^3}{x}\end{aligned}$$

6) $y = e^{e^{3x^2}}$

$$\begin{aligned}\frac{dy}{dx} &= e^{e^{3x^2}} e^{3x^2} \cdot 6x \\ &= 6xe^{e^{3x^2} + 3x^2}\end{aligned}$$

7) $y = e^{(4x^3 + 5)^2}$

$$\begin{aligned}\frac{dy}{dx} &= e^{(4x^3 + 5)^2} \cdot 2(4x^3 + 5) \cdot 12x^2 \\ &= 24x^2 e^{(4x^3 + 5)^2} (4x^3 + 5)\end{aligned}$$

8) $y = \ln 4x^2 \cdot (-x^3 - 4)$

$$\begin{aligned}\frac{dy}{dx} &= \ln 4x^2 \cdot -3x^2 + (-x^3 - 4) \cdot \frac{1}{4x^2} \cdot 8x \\ &= \frac{-3x^3 \ln 4x^2 - 2x^3 - 8}{x}\end{aligned}$$

9) $y = \ln \left(-\frac{4x^4}{x^3 - 3} \right)^5$

$$\begin{aligned}\frac{dy}{dx} &= 5 \left(\frac{1}{-4x^4} \cdot -16x^3 - \frac{1}{x^3 - 3} \cdot 3x^2 \right) \\ &= \frac{5(x^3 - 12)}{x(x^3 - 3)} \text{ (Rules of logarithms used)}\end{aligned}$$

10) $y = \frac{e^{5x^4}}{e^{4x^2 + 3}}$

$$\begin{aligned}\frac{dy}{dx} &= e^{5x^4 - (4x^2 + 3)} (20x^3 - 8x) \\ &= 4xe^{5x^4 - 4x^2 - 3} (5x^2 - 2) \text{ (Rules of exponents used)}\end{aligned}$$