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

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

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**Differentiate each function with respect to $x$.**

1) $y = \ln x^3$

$$\frac{dy}{dx} = \frac{1}{x^3} \cdot 3x^2$$
$$= \frac{3}{x}$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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