

## 3.9 Derivatives of Exponential and Logarithmic Functions

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### Exponential and Logarithmic Function Derivatives

$$D_x e^u = e^u \frac{du}{dx} \qquad D_x a^u = a^u \ln a \frac{du}{dx}$$

$$D_x \ln u = \frac{1}{u} \frac{du}{dx} \qquad D_x \log_a u = \frac{1}{u \ln a} \frac{du}{dx}$$

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### Logarithmic Differentiation

(1) Take the natural log of both sides of the equation

(2) Differentiate both sides

(3) Isolate  $\frac{dy}{dx}$

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For problems 1 – 10, find the derivative.

1.  $y = e^{-\frac{x}{2}}$

2.  $y = x^3 e^x + \sqrt{x} e^{2x}$

3.  $y = x^{3e+2}$

4.  $y = 4^{-x}$

5.  $y = 5^{\sin x}$

6.  $y = \ln\left(\frac{5}{x^2}\right)$

7.  $y = \ln(5 + \cos x)$

8.  $y = \ln(\log_5 x^2)$

9.  $y = \log_3(e^x)$

10.  $y = \frac{1}{\log_6(x - 2)}$

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For problems 11 and 12, find the derivative using logarithmic differentiation.

11.  $y = (\cos x)^x$

12.  $y = \frac{x^2 \sqrt{4x - 3}}{(x^2 + 1)^{\frac{3}{4}}}$

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13. Find the equations of the tangent and normal lines to the curve  $y^2(2 - x) = x^3$  at the point  $(1, 1)$ .

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14. Find points on the curve  $x^2 + xy + y^2 = 7$  where the tangent line is horizontal, and where the tangent line is vertical.