

1. Let $f(x) = \ln(x)$, $g(x) = x^2 + 3x$, and $h(x) = \cos(x)$. Find the following compositions and derivatives.

(a) $(f \circ g)(x)$, $(f \circ g)'(x)$

i. $(f \circ g)(x)$:

$$(f \circ g)(x) = \ln(x^2 + 3x).$$

ii. $(f \circ g)'(x)$:

$$(f \circ g)'(x) = \frac{1}{x^2 + 3x} \cdot (2x + 3)$$

(b) $(g \circ f)(x)$, $(g \circ f)'(x)$

i. $(g \circ f)(x)$:

$$(g \circ f)(x) = (\ln(x))^2 + 3(\ln(x)).$$

ii. $(g \circ f)'(x)$:

$$(g \circ f)'(x) = (2\ln(x) + 3) \cdot \left(\frac{1}{x}\right)$$

(c) $(h \circ g)(x)$, $(h \circ g)'(x)$

i. $(h \circ g)(x)$:

$$(h \circ g)(x) = \cos(x^2 + 3x).$$

ii. $(h \circ g)'(x)$:

$$(h \circ g)'(x) = \sin(x^2 + 3x)(2x + 3)$$

2. Find the derivatives of the following functions.

(a) $(3x^2 + 2)^{14}$

$$\frac{d}{dx}(3x^2 + 2)^{14} = 14(3x^2 + 2)^{13}(6x)$$

(b) $\ln(\sin x)$

$$\frac{d}{dx}(\ln(\sin(x))) = \frac{\cos(x)}{\sin(x)} = \cot(x)$$

(c) $3 \cos(\sqrt{x})$

$$\frac{d}{dx}(3 \cos(\sqrt{x})) = -\frac{3 \sin(\sqrt{x})}{2\sqrt{x}}$$

(d) $e^{(x^2)}$

$$\frac{d}{dx}(e^{(x^2)}) = 2xe^{x^2}$$

(e) $(e^x)^2$

$$\frac{d}{dx}(e^{2x}) = 2e^{2x}.$$

(f) $\tan(3x^3 + 7x)$

$$\frac{d}{dx}(\tan(3x^3 + 7x)) = (9x^2 + 7) \sec^2(3x^3 + 7x).$$

(g) $\cos(8^x)$

$$\frac{d}{dx}(\cos(8^x)) = -\ln(8)8^x \sin(8^x).$$

(h) $8^{\cos(x)}$

$$\frac{d}{dx}(8^{\cos(x)}) = -\ln(8) \sin(x) 8^{\cos(x)}.$$

(i) $\tan(\sin(3x))$

$$\frac{d}{dx}(\tan(\sin(3x))) = 3 \sec^2(\sin(3x)) \cos(3x).$$

(j) $e^{\cos(3x)}$

$$\frac{d}{dx}(e^{\cos(3x)}) = -3 \sin(3x) e^{\cos(3x)}.$$

(k) $(\sin(3x^2))^2$

$$\frac{d}{dx}((\sin(3x^2))^2) = 12x \sin(3x^2) \cos(3x^2).$$

(l) $\sqrt{\ln(x^2 + 2x)}$

$$\frac{d}{dx}(\sqrt{\ln(x^2 + 2x)}) = \frac{1}{2}(\ln(x^2 + 2x))^{-1/2} \cdot \frac{1}{x^2 + 2x} \cdot (2x + 2)$$