

Warm-ups. Determine functions  $f$  and  $g$  so that the given function is equal to  $f \circ g$ .

1.  $y = \sqrt{7x + 3}$

2.  $h(x) = \sin(2x + 1)$

3.  $h(x) = e^{17x-3x^3}$

The Chain Rule:  $\frac{d}{dx}(f(g(x))) = f'(g(x)) \cdot g'(x)$

The Chain Rule, Alternate Form: If  $y = f(u)$  and  $u = g(x)$ , then  $\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}$

Exercises. Use the chain rule to differentiate the following functions.

1.  $y = \sqrt{7x + 3}$

2.  $h(x) = \sin(2x + 1)$

3.  $h(x) = e^{17x-3x^3}$

4. Find  $\frac{dy}{dx}$  if  $y = \tan(u)$  and  $u = \frac{x}{x+3}$ .

5.  $y = (\cos(x))(x^2 - 13)^{17}$

6.  $y = 3^x$

7.  $f(x) = \sin((x^2 + 3)^{3/4})$

8.  $f(x) = \sqrt{x \sec(x)}$

9.  $y = \sqrt[3]{x^3 - 12} - \sqrt[3]{1 - x^2}$

10.  $f(x) = \left(\frac{x^2}{2x - 5}\right)^3$

11. Suppose that  $G(x) = \sin(f(x))$  and  $F(x) = f(\sin(x))$ . You also know that  $f(a) = \pi/3$ ,  $\cos(a) = 1/2$ ,  $f'(a) = -3$ , and  $f'(\sin(a)) = 10$ . Determine  $G'(a)$  and  $F'(a)$ .

12. If  $\frac{d}{dx}(\text{car}(x)) = \text{truck}(x)$  and  $\frac{d}{dx}(\text{soup}(x)) = \text{sandwich}(x)$ , differentiate the following functions.

(a)  $y = (\text{car}(x))^3$

(b)  $h(x) = \text{soup}(x^4)$

(c)  $y = \text{car}(\text{soup}(x))$