

Name: \_\_\_\_\_

## 11.1 The Chain Rule

**Exercise 11.1.1** Use the chain rule to take the derivative of the following functions.

a.  $h(t) = \cos(\sqrt{t})$

c.  $y = 3^{5 \cos(x)}$

b.  $z(\theta) = \sin^4(\theta)$

d.  $y = (x^3 - 1)^{100}$

**Exercise 11.1.2** Differentiate the following functions by using the chain rule multiple times.

a.  $f(x) = \sin(\cos(\tan(x)))$

b.  $g(\theta) = e^{\sec(3\theta^4)}$

**Exercise 11.1.3** Combine the chain rule, product rule, and quotient rule appropriately in order to differentiate the following functions.

a.  $f(x) = \sin(xe^x)$

c.  $g(x) = x \sin(e^x)$

b.  $y = \frac{\tan(2^x)}{x}$

d.  $z = 5t + \frac{\cos^2(t^2)}{3}$

**Exercise 11.1.4** Convert the following rational functions into a product with a negative exponent and then use the product and chain rule to find the derivative.

a.  $g(x) = \frac{1}{x^2 + 1}$

b.  $f(x) = \frac{3e^x + 5}{\sin(x)}$

**Exercise 11.1.5** Suppose that Carla is jogging in her sweet new running shoes. Suppose further that  $r = f(t)$  is Carla's pace (in mph)  $t$  hours after 1 : 00 pm and  $y = h(r)$  is Carla's heart rate (in bpm) when she jogs at a rate of  $r$  mph.

a. What is the meaning of  $f(0.75) = 7$ ?

b. What is the meaning of  $h(7) = 125$ ?

c. What is the meaning of  $(h \circ f)(0.75) = 125$ ?

d. What is the meaning of  $\left. \frac{dr}{dt} \right|_{t=0.75} = -0.00003$ ?

e. What is the meaning of  $\left. \frac{dy}{dr} \right|_{r=7} = 8$ ?

f. Given the values above, what is the value of  $\left. \frac{dy}{dt} \right|_{t=0.75}$ ? Interpret the value in context of the situation.

## 11.2 Derivatives of Parametric Equations

**Exercise 11.2.1** Use Geogebra to graph the parametric curve given by

$$x(t) = -3 \cos(3t) \qquad y(t) = 1 + \sin(2t).$$

Then find the equation of the tangent lines to the parametric curve at the point  $(0, 1)$ . At what points does this function have vertical tangents?