Name: ______________________________

1. Warm Up Part I: Compute the following derivatives.

   - $\frac{d}{dx}(x^2 + 3x + 4)$

   - $\frac{d}{dz}(e^{3z} + 2x^3 - 4z^2)$

   - $\frac{d}{dx}(\frac{1}{\sqrt[3]{x}} + x^{\frac{7}{8}} + x^{-2} + \frac{1}{x^{-3}})$

   - $\frac{d}{dx}(e^{(9x^4+3)})$

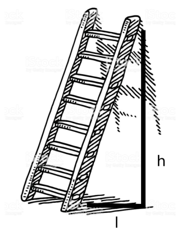
   - $\frac{d}{dx}((e^4x)^3 + (3e^4x)^2 + 6e^4x)$

2. Warm Up Part I: Try to name all of the differentiation laws you used in warm up part I.

   (Hopefully you didn't use the limit definition of the derivative for all of them)

3. Now let's dig deeper into chain rule and see how it fits in with applications.

   We might as well practice some trig while we're at it! Suppose we have a 5 ft ladder resting against a wall. Write a formula for the height of the ladder on the wall (h) as a function of the length between the base of the ladder and the base of the wall (l).



4. Now find an expression for the change in height with respect to change in length, $\frac{dh}{dl}$, when the ladder is at some given length from the wall.

5. For practice, see if you can find an expression for $\frac{dl}{dh}$ when the ladder is at some given height.

6. Now suppose we start with no distance between the base of the ladder and the base of the wall and Ian begins to pull the base of the ladder away from the wall so after t seconds, the base is t^2 ft away from the wall. What is $\frac{dh}{dl}$ when $t = 2$. What is $\frac{dl}{dt}$ when $t = 2$? What is $\frac{dh}{dt}$ when $t = 2$? Are they the same? Why or why not?

7. Is there any relation between $\frac{dh}{dl}$, $\frac{dl}{dt}$, and $\frac{dh}{dt}$ when $t = 2$. Is there any relation in general? How does this relate to the chain rule?

8. Exercises

- Given three differentiable functions, f, g, and h, find an expression for $\frac{d}{dx}\Big(f(g(h(x)))\Big)$.

- Find an expression for $\frac{d}{dx}\left(\frac{1}{f(x)}\right)$.

- Differentiate $f(x) = e^{e^{e^x}}$.

- If f is some polynomial, can we choose some number n large enough f so that the n^{th} derivative of f will be zero everywhere? Why or why not? Can you find a function where the opposite is true?

- On the quiz we had a question that was TOO HARD about when differentiable functions can be continuous. Here is a nicer question to think about:

  If a function f is strictly increasing and differentiable for all real numbers, can f' have a jump discontinuity? That is, can we have that $f'(a)$ is defined, and that $\lim_{x\to a^+} f'(x)$ and $\lim_{x\to a^+} f'(x)$ both exist, but

  $$\lim_{x\to a^+} f'(x) \neq \lim_{x\to a^+} f'(x)?$$