Rules of Differentiation

We have the following rules of differentiation. In all cases, f and g are differentiable functions. **MATH 139–02**

Name	Conditions	Rule	Example 1	Example 2
Constant Rule	c is a constant	$\frac{d}{dx}(c) = 0$	$\frac{d}{dx}(5) = 0$	$\frac{d}{dx}(-4,856,324) = 0$
Power Rule	n is a constant	$\frac{d}{dx}(x^n) = nx^{n-1}$	$\frac{d}{dx}(x^6) = 6x^5$	$\frac{d}{dx}x^{-1} = -x^{-2}$
Constant Multiple Rule	c is a constant	$\frac{d}{dx}(cf(x)) = cf'(x)$	$\frac{d}{dx}(3x^4) = 3 \cdot 4x^3$	$\frac{d}{dx}(-5x^{3/4}) = -5 \cdot \frac{3}{4}x^{-1/4}$
Natural Logarithm		$\frac{d}{dx}(\ln(x)) = \frac{1}{x}$		
Natural Exponential		$\frac{d}{dx}(e^x) = e^x$		
Exponential functions	$a > 0$, a is constant	$\frac{d}{dx}(a^x) = a^x \ln(a)$	$\frac{d}{dx}(3^x) = 3^x \ln(3)$	$\frac{d}{dx}[3(1.05)^x]$ $= 3 \cdot (1.05)^x \ln(1.05)$
Sum/Difference **Rules**		$\frac{d}{dx}(f(x) \pm g(x)) = f'(x) \pm g'(x)$	$\frac{d}{dx}(e^x + x^4) = e^x + 4x^3$	$\frac{d}{dx}(3x^3 + 5x^2 - 1)$ $= 3 \cdot 3x^2 + 5 \cdot 2x$
Product Rule		$\frac{d}{dx}(f(x) \cdot g(x))$ $= f'(x)g(x) + g'(x)f(x))$	$\frac{d}{dx}(x^2(x^3 - 2))$ $= 2x(x^3 - 2) + 3x^2(x^2)$	$\frac{d}{dx}(x^2 \ln(x))$ $= 2x \ln(x) + \frac{1}{x}(x^2)$
Quotient Rule	$g(x) \neq 0$	$\frac{d}{dx}\left(\frac{f(x)}{g(x)}\right)$ $= \frac{f'(x)g(x) - g'(x)f(x)}{[g(x)]^2}$	$\frac{d}{dx}\left(\frac{x}{x^2+1}\right)$ $= \frac{1(x^2+1) - 2x(x)}{(x^2+1)^2}$	$\frac{d}{dx}\left(\frac{e^x}{x}\right)$ $= \frac{e^x(x) - 1(e^x)}{x^2}$
Chain Rule		$\frac{d}{dx}(f(g(x))) = f'(g(x))g'(x)$	$\frac{d}{dx}(e^{x^2+3x}) = e^{x^2+3x}(2x+3)$	$\frac{d}{dx}((x^3 + 2x)^4)$ $= 4(x^3 + 2x)^3(3x^2 + 2)$