Section 2.4 - Products & Quocents ; Higher order deriv.

Product Rule: $\frac{d}{dx} f(x)g(x) = f'(x)g(x) + f(x)g'(x)$

Quocent Rule: $\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{f'(x)g(x) - f(x)g'(x)}{[g(x)]^2}$ *order matters*

Bonus Quocent Rule: $\frac{d}{dx}\left[\frac{1}{g(x)}\right] = \frac{-g'(x)}{[g(x)]^2}$

Higher Order Derivatives - derivative of the derivative

ex: $\frac{d}{dx}\frac{dy}{dx} = \frac{ddy}{dxdx} = \frac{d^2y}{dx^2}$ - second order derivative

Recilinear Motion: position $\rightarrow f(x)$
velocity $\rightarrow f'(x)$ $\frac{ds}{dt}$
acceleration $\rightarrow f''(x)$ $\frac{d^2s}{dt^2} = \frac{dv}{dt}$ - over time

Galileo's Law: - position of an object in a vaccume; only exposed to gravity

$S = -ct^2$

Examples:

- $f(x) = x^2 e^x$ $f'(x) = 2x e^x + e^x x^2$
- $f(x) = x^4 (x+5)$ $f'(x) = 4x^3(x+5) + x^4$
- $f(x) = (3x-2)(4x+5)$ $f'(x) = 3(4x+5) + 4(3x-2) = 24x + 7$

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- $F(u) = (u^4 - 3u^2 + 1)(u^2 - u + 2)$ $\quad F'(u) = (4u^3 - 6u)(u^2 - u + 2) + (2u + 1)(u^4 - 3u^2 + 1)$
- $f(x) = (x^2+1)(e^x + x)$ $\quad f'(x) = (2x)(e^x + x) + (e^x + 1)(x^2 + 1)$
- $f(z) = \frac{z+1}{2z}$ $\quad f'(z) = \frac{2z - (z+1)(2)}{2z^2}$
- $f(w) = \frac{1-w^2}{1+w^2}$ $\quad f'(w) = \frac{(-2w)(1+w^2) - 2w(1-w^2)}{(1+w^2)^2}$
- $G(u) = u^{-4}$ $\quad G'(u) = \frac{-4u^3}{(u^4)^2}$
- $f(x) = x^5 - \frac{5}{x^5}$ $\quad f'(x) = 5x^4 - \frac{25x^4}{(x^5)^2}$
- * $f(x) = \frac{xe^x}{x^2 - x}$ $\quad f'(x) = \frac{(e^x + xe^x)(x^2 - x) - (xe^x)(2x-1)}{(x^2-x)^2}$

Find the first & 2nd Derivatives

- $f(x) = -5x^2 - 3x$ $\quad f'(x) = -10x - 3$ $\quad f''(x) = -10$
- $f(x) = x - e^x$ $\quad f'(x) = 1 - e^x$ $\quad f''(x) = -e^x$
- $f(x) = 3x^4e^x$ $\quad f'(x) = (12x^3)e^x + (3x^4)e^x$ $\quad f''(x) = (36x^2)e^x + 12x^3e^x + 12x^3e^x + 3x^4e^x$
- * $f(x) = \frac{e^x}{x}$ $\quad f'(x) = \frac{e^x x - e^x}{x^2}$ $\quad f''(x) = \frac{(xe^x + e^x - e^x)x^2 - 2x(e^x x - e^x)}{(x^2)^2}$
- $f(x) = x - \frac{1}{x}$ $\quad f'(x) = 1 + \frac{1}{x^2}$ $\quad f''(x) = \frac{-2x}{(x^2)^2}$