Recall from yesterday's 3.1 Notes:

(d) $f(x) = \dfrac{x^2 + x - 1}{\sqrt{x}} = x^{\frac{3}{2}} + x^{\frac{1}{2}} - x^{-\frac{1}{2}}$

$$f'(x) = \frac{3}{2}x^{\frac{1}{2}} + \frac{1}{2}x^{-\frac{1}{2}} + \frac{1}{2}x^{-\frac{3}{2}}$$

Why didn't we find $f'(x)$ as:

$$f'(x) = \frac{2x+1}{\frac{1}{2}x^{-1/2}} \; ?$$

Ans: It's wrong, that's why!

Enlightening Examples:

$$f(x) = x = \frac{x^3}{x^2}$$

$f(x) = x$

$f'(x) = 1$

$f(x) = \dfrac{x^3}{x^2}$

~~try out idea:~~

$\cancel{f(x) = \dfrac{3x^2}{2x} = \dfrac{3}{2}x}$

wrong answer!

$$f(x) = x^3 = x \cdot x^2$$

$f(x) = x^3$

$f'(x) = 3x^2$

$\cancel{f(x) = x \cdot x^2}$

$\cancel{f'(x) = 1 \cdot 2x = 2x}$

wrong answer

Just take product of derivatives

Tell you the rules

SECTION 3.1 PRODUCT RULE AND QUOTIENT RULE

1. Complete **The Product Rule:** If f and g are differentiable, then

short hand

$$\frac{d}{dx}[f(x)g(x)] = f(x)\cdot\left[\frac{d}{dx}g(x)\right]+\left[\frac{d}{dx}f(x)\right]\cdot g(x) = f\cdot g' + f'\cdot g$$

2. Complete **The Quotient Rule:** If f and g are differentiable, then

$$\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x)\cdot\left[\frac{d}{dx}(f(x))\right]-f(x)\cdot\left[\frac{d}{dx}[g(x)]\right]}{[g(x)]^2} = \frac{g\cdot f' - f\cdot g'}{(g)^2}$$

3. Find the derivatives for each function below. Do not use the Product Rule or the Quotient Rule if you

Simple Examples :

$$h(x) = \underset{f}{x^2}\,\underset{g}{e^x}$$

$$h'(x) = \overset{f}{x^2}\cdot\overset{g'}{e^x} + \overset{f'}{2x}\cdot\overset{g}{e^x}$$

$$= x^2e^x + 2xe^x$$

$$= \boxed{xe^x(x+2)}$$

$$h(x) = \frac{\overset{f}{x^2}}{\underset{g}{e^x+1}}$$

$$h'(x) = \frac{\overset{g}{(e^x+1)}\cdot\overset{f'}{(2x)} - \overset{f}{(x^2)}\cdot\overset{g'}{(e^x)}}{\underset{g^2}{(e^x+1)^2}}$$

$$= \boxed{\frac{2xe^x + 2x - x^2e^x}{(e^x+1)^2}}$$

Why do these rules work?

$$H(x) = f(x) \cdot g(x)$$

$$H'(x) = \lim_{h \to 0} \frac{H(x+h) - H(x)}{h}$$

$$= \lim_{h \to 0} \frac{f(x+h)g(x+h) - f(x)g(x) + f(x)g(x+h) - f(x)g(x+h)}{h}$$

$$= \lim_{h \to 0} g(x+h)\left[\frac{f(x+h) - f(x)}{h}\right] + f(x)\left[\frac{g(x+h) - g(x)}{h}\right]$$

$$= g(x) \cdot f'(x) + f(x) \cdot g'(x)$$