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$\frac{d}{dx}[\sin x] = \cos x$ $\frac{d}{dx}[\cos x] = -\sin x$

$y = 3x^3 - 2x + 6\cos x$

$\boxed{y' = 9x^2 - 2 - 6\sin x}$

$y = (3x^2+4x)(2x-8) = 6x^3 + 8x^2 - 24x^2 - 32x = 6x^3 - 16x^2 - 32x$

$y' = 18x^2 - 32x - 32$

Product Rule

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

"the deriv. of 1st times 2nd plus 1st times deriv of 2nd"

$y = 6x^2 \sin x$

$\boxed{y' = 12x\sin x + 6x^2\cos x}$

$y = (3x^2+4x)(2x-8)$

$y' = (6x+4)(2x-8) + (3x^2+4x)(2) = 12x^2 + 8x - 48x - 32 + 6x^2 + 8$

$= 18x^2 - 32x - 32$ ✓

$y = x^3\cos x - 4x^2\sin x$

$y' = 3x^2\cos x - x^3\sin x - 8x\sin x - 4x^2\cos x$

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

Quotient Rule

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

"deriv of top times bottom minus top times deriv of bottom all over bottom squared"

① $y = \dfrac{4x^3 - 3x^2 + 1}{2x^3 - 6}$

$$y' = \frac{(12x^2 - 6x)(2x^3 - 6) - (4x^3 - 3x^2 + 1)(6x^2)}{(2x^3 - 6)^2}$$

② $y = \dfrac{\sqrt{x} - x^3}{\sin x}$ $\quad y' = \dfrac{(\frac{1}{2}x^{-1/2} - 3x^2)(\sin x) - (\sqrt{x} - x^3)(\cos x)}{(\sin x)^2}$ $\Rightarrow \sin^2 x$

$\neq \sin x^2$

③ $y = 4x^3 - \dfrac{3}{2x^2 + 1}$

$$y' = 12x^2 - \left(\frac{0 - 3(4x)}{(2x^2+1)^2}\right) = \boxed{12x^2 + \frac{12x}{(2x^2+1)^2}}$$

④ $f(x) = \dfrac{4x\cos x}{x^3 - 2}$

$$f'(x) = \frac{(4\cos x - 4x\sin x)(x^3 - 2) - (4x\cos x)(3x^2)}{(x^3 - 2)^2}$$

$$y = \tan x = \frac{\sin x}{\cos x}$$

$$y' = \frac{\cos x \cos x - \sin x(-\sin x)}{\cos^2 x} = \frac{\overset{1}{\cancel{\cos^2 x + \sin^2 x}}}{\cos^2 x} = \sec^2 x$$

$$\frac{d}{dx}[\tan x] = \sec^2 x \qquad \frac{d}{dx}[\cot x] = -\csc^2 x$$

$$y = \sec x = \frac{1}{\cos x}$$

$$y' = \frac{0 + \sin x}{\cos^2 x} = \frac{1}{\cos x} \cdot \frac{\sin x}{\cos x} = \sec x \tan x$$

$$\frac{d}{dx}[\sec x] = \sec x \tan x \qquad \frac{d}{dx}[\csc x] = -\csc x \cot x$$