# Section 3.2

## Product Rule

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

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**Ex** $f(x) = (2x^2-1)(x^3+3)$

$$f'(x) = \frac{d}{dx}\left[\underbrace{(2x^2-1)}_{p(x)}\underbrace{(x^3+3)}_{q(x)}\right] = p(x)q'(x) + p'(x)q(x)$$

$$= (2x^2-1)(3x^2) + (4x)(x^3+3)$$
$$= 6x^4 - 3x^2 + 4x^4 + 12x$$
$$= 10x^4 - 3x^2 + 12x$$

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**Ex** $f(x) = x^3(\sqrt{x}+1)$

$$f'(x) = x^3\frac{d}{dx}[\sqrt{x}+1] + \frac{d}{dx}[x^3](\sqrt{x}+1)$$
$$= x^3(\tfrac{1}{2}x^{-1/2}) + 3x^2(\sqrt{x}+1)$$
$$= \tfrac{1}{2}x^{5/2} + 3x^{5/2} + 3x^2$$
$$= \tfrac{7}{2}x^{5/2} + 3x^2$$

## Quotient Rule

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

provided $g(x) \neq 0$

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EX $\quad f(x) = \dfrac{x}{2x-4}$ ← $q(x)$, ← $p(x)$

$$f'(x) = \frac{p(x)\,q'(x) - q(x)\,p'(x)}{[p(x)]^2}$$

$$= \frac{(2x-4)\frac{d}{dx}[x] - x\frac{d}{dx}[2x-4]}{[2x-4]^2}$$

$$= \frac{2x-4-2x}{4x^2-16x+16}$$

$$= \frac{-4}{4x^2-16x+16} \quad \text{or} \quad \frac{-4}{(2x-4)^2}$$

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EX $\quad f(x) = \dfrac{x^2+1}{x^2-1}$

$$f'(x) = \frac{(x^2-1)\frac{d}{dx}[x^2+1] - (x^2+1)\frac{d}{dx}[x^2-1]}{(x^2-1)^2}$$

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

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

$$= \frac{-4x}{(x^2-1)^2}$$

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