

Cálculo 2 - 2025.2

O “Example 6” da p.131 do Stewart 7
e alguns outros objetos expansíveis

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<http://anggtwu.net/2025.2-C2.html>

Links

Example 6 (Stewart 7, p.131)

EXAMPLE 6 Find $F'(x)$ if $F(x) = (6x^3)(7x^4)$.

SOLUTION By the Product Rule, we have

$$\begin{aligned} F'(x) &= (6x^3) \frac{d}{dx} (7x^4) + (7x^4) \frac{d}{dx} (6x^3) \\ &= (6x^3)(28x^3) + (7x^4)(18x^2) \\ &= 168x^6 + 126x^6 = 294x^6 \end{aligned}$$

Notice that we could verify the answer to Example 6 directly by first multiplying the factors:

$$F(x) = (6x^3)(7x^4) = 42x^7 \quad \Rightarrow \quad F'(x) = 42(7x^6) = 294x^6$$

But later we will meet functions, such as $y = x^2 \sin x$, for which the Product Rule is the only possible method.

Notas de 2023

De: Stew2p31 (p.131)

$$\begin{aligned}
 F(x) &= (6x^3)(7x^4) \\
 F'(x) &= (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \frac{d}{dx}(6x^3) \\
 &= (6x^3)(28x^3) + (7x^4)(18x^2) \\
 &= 168x^6 + 126x^6 \\
 &= 294x^6
 \end{aligned}$$

[RC]	=	$\left(\frac{d}{dx}c = 0\right)$	Veja StewPtCap3p5
[RPot]	=	$\left(\frac{d}{dx}x^n = nx^{n-1}\right)$	Veja StewPtCap3p7
[RMC]	=	$\left(\frac{d}{dx}(cf(x)) = c\frac{d}{dx}f(x)\right)$	Veja StewPtCap3p8
[RSoma]	=	$\left(\frac{d}{dx}(f(x) + g(x)) = \frac{d}{dx}f(x) + \frac{d}{dx}g(x)\right)$	Veja StewPtCap3p5
[RProd]	=	$\left(\frac{d}{dx}(f(x)g(x)) = f(x)\frac{d}{dx}g(x) + g(x)\frac{d}{dx}f(x)\right)$	Veja StewPtCap3p14

$$\begin{aligned}
 F(x) &= (6x^3)(7x^4) \\
 F'(x) &= ((6x^3)(7x^4))' \\
 &= \frac{d}{dx}((6x^3)(7x^4)) \\
 &= (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \frac{d}{dx}(6x^3) && \text{Por [RProd] com } f(x) = 6x^3, g(x) = 7x^4 \\
 &= (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \frac{d}{dx}x^3 && \text{Por [RMC] com } c = 6, f(x) = x^3 \\
 &= (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot 3x^2 && \text{Por [RPot] com } n = 3 \\
 &= (6x^3) \frac{d}{dx}(7x^4) + (7x^4)(18x^2) \\
 &= (6x^3) \cdot 7 \frac{d}{dx}x^4 + (7x^4)(18x^2) && \text{Por [RMC] com } c = 7, f(x) = x^4 \\
 &= (6x^3) \cdot 7 \cdot 4x^3 + (7x^4)(18x^2) && \text{Por [RPot] com } n = 4 \\
 &= (6x^3)(28x^3) + (7x^4)(18x^2) \\
 &= (6x^3)(28x^3) + 126x^6 \\
 &= 168x^6 + 126x^6 \\
 &= 294x^6
 \end{aligned}$$

Notas de 2023 (2)

$$\begin{aligned}
 F(x) &= (6x^3)(7x^4) \\
 F'(x) &= ((6x^3)(7x^4))' \\
 &= \frac{d}{dx}((6x^3)(7x^4)) \\
 &\equiv (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \frac{d}{dx}(6x^3) \quad \text{Por [RProd] com } f(x) = 6x^3, g(x) = 7x^4 \\
 &= (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \frac{d}{dx}x^3 \quad \text{Por [RMC] com } c = 6, f(x) = x^3 \\
 &= (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot 3x^2 \quad \text{Por [RPot] com } n = 3 \\
 &= (6x^3) \frac{d}{dx}(7x^4) + (7x^4)(18x^2) \\
 &= (6x^3) \cdot 7 \frac{d}{dx}x^4 + (7x^4)(18x^2) \quad \text{Por [RMC] com } c = 7, f(x) = x^4 \\
 &= (6x^3) \cdot 7 \cdot 4x^3 + (7x^4)(18x^2) \quad \text{Por [RPot] com } n = 4 \\
 &= (6x^3)(28x^3) + (7x^4)(18x^2) \\
 &= (6x^3)(28x^3) + 126x^6 \\
 &= 168x^6 + 126x^6 \\
 &= 294x^6
 \end{aligned}$$

Compare: nós definimos [RProd] como esta igualdade,

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

e se substituirmos $f(x)$ por $6x^3$ e $g(x)$ por $7x^4$ na igualdade [RProd] nós obtemos isto aqui,

$$\begin{aligned}
 [\text{RProd}] &= \left(\frac{d}{dx}(f(x)g(x)) = f(x) \frac{d}{dx}g(x) + g(x) \frac{d}{dx}f(x) \right) \\
 [\text{RProd}] \begin{bmatrix} f(x) \\ g(x) \end{bmatrix} &:= \begin{bmatrix} 6x^3 \\ 7x^4 \end{bmatrix} = \left(\frac{d}{dx}((6x^3)(7x^4)) \equiv (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \frac{d}{dx}(6x^3) \right)
 \end{aligned}$$

que é exatamente a igualdade que eu marquei lá em cima...

Notas de 2023 (3)

$$\begin{aligned}
 F(x) &= (6x^3)(7x^4) \\
 F'(x) &= ((6x^3)(7x^4))' \\
 &= \frac{d}{dx}((6x^3)(7x^4)) \\
 &= (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \frac{d}{dx}(6x^3) \quad \text{Por [RProd] com } f(x) = 6x^3, g(x) = 7x^4 \\
 &= (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \frac{d}{dx}x^3 \quad \text{Por [RMC] com } c = 6, f(x) = x^3 \\
 &= (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot 3x^2 \quad \text{Por [RPot] com } n = 3 \\
 &= (6x^3) \left(\frac{d}{dx}(7x^4) \right) + (7x^4)(18x^2) \\
 &\stackrel{=}{=} (6x^3) \cdot 7 \frac{d}{dx}x^4 + (7x^4)(18x^2) \quad \text{Por [RMC] com } c = 7, f(x) = x^4 \\
 &= (6x^3) \cdot 7 \cdot 4x^3 + (7x^4)(18x^2) \quad \text{Por [RPot] com } n = 4 \\
 &= (6x^3)(28x^3) + (7x^4)(18x^2) \\
 &= (6x^3)(28x^3) + 126x^6 \\
 &= 168x^6 + 126x^6 \\
 &= 294x^6
 \end{aligned}$$

Lembre que a “regra da multiplicação por constante” é esta igualdade aqui,

$$[\text{RMC}] = \left(\frac{d}{dx}(cf(x)) = c \frac{d}{dx}f(x) \right)$$

e se substituirmos c por 7 e $f(x)$ por x^4 nela nós obtemos isto aqui,

$$\begin{aligned}
 [\text{RMC}] &= \left(\frac{d}{dx}(cf(x)) = c \frac{d}{dx}f(x) \right) \\
 [\text{RMC}] \left[\begin{array}{l} c := 7 \\ f(x) := x^4 \end{array} \right] &= \left(\frac{d}{dx}(7x^4) \stackrel{=}{=} 7 \frac{d}{dx}x^4 \right)
 \end{aligned}$$

O “ $\stackrel{=}{=}$ ” logo acima desta frase justifica a parte que muda no “ $\stackrel{=}{=}$ ” lá de cima!

$$\begin{aligned}((6x^3)(7x^4))' &= \frac{d}{dx}((6x^3)(7x^4)) \\&= (6x^3)\frac{d}{dx}(7x^4) + (7x^4)\frac{d}{dx}(6x^3) \\&= (6x^3)\frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot \frac{d}{dx}x^3 \\&= (6x^3)\frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot 3x^2 \\&= (6x^3)\frac{d}{dx}(7x^4) + (7x^4)(18x^2) \\&= (6x^3) \cdot 7 \frac{d}{dx}x^4 + (7x^4)(18x^2) \\&= (6x^3) \cdot 7 \cdot 4x^3 + (7x^4)(18x^2) \\&= (6x^3)(28x^3) + (7x^4)(18x^2) \\&= (6x^3)(28x^3) + 126x^6 \\&= 168x^6 + 126x^6 \\&= 294x^6\end{aligned}$$

$$\begin{aligned}
((6x^3)(7x^4))' &\stackrel{(1)}{=} \frac{d}{dx}((6x^3)(7x^4)) \\
&\stackrel{(2)}{=} (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \frac{d}{dx}(6x^3) \\
&\stackrel{(3)}{=} (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot \frac{d}{dx}x^3 \\
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\end{aligned}$$

$$((6x^3)(7x^4))'$$

$$\stackrel{(1)}{=}$$

$$\frac{d}{dx}((6x^3)(7x^4))$$

$$\stackrel{(2)}{=}$$

$$(6x^3)\frac{d}{dx}(7x^4) + (7x^4)\frac{d}{dx}(6x^3)$$

$$\stackrel{(3)}{=}$$

$$(6x^3)\frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot \frac{d}{dx}x^3$$

$$\stackrel{(4)}{=}$$

$$(6x^3)\frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot 3x^2$$

$$\stackrel{(5)}{=}$$

$$(6x^3)\frac{d}{dx}(7x^4) + (7x^4)(18x^2)$$

$$\stackrel{(6)}{=}$$

$$(6x^3) \cdot 7 \frac{d}{dx}x^4 + (7x^4)(18x^2)$$

$$\stackrel{(7)}{=}$$

$$(6x^3) \cdot 7 \cdot 4x^3 + (7x^4)(18x^2)$$

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\end{aligned}$$

$$((6x^3)(7x^4))'$$

$$\stackrel{(1)}{=}$$

$$\frac{d}{dx}((6x^3)(7x^4))$$

$$\stackrel{(2)}{=}$$

$$(6x^3)\frac{d}{dx}(7x^4) + (7x^4)\frac{d}{dx}(6x^3)$$

$$\stackrel{(3)}{=}$$

$$(6x^3)\frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot \frac{d}{dx}x^3$$

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$$\stackrel{(5)}{=}$$

$$(6x^3)\frac{d}{dx}(7x^4) + (7x^4)(18x^2)$$

$$\stackrel{(6)}{=}$$

$$(6x^3) \cdot 7 \frac{d}{dx}x^4 + (7x^4)(18x^2)$$

$$\stackrel{(7)}{=}$$

$$(6x^3) \cdot 7 \cdot 4x^3 + (7x^4)(18x^2)$$

$$\stackrel{(8)}{=}$$

$$(6x^3)(28x^3) + (7x^4)(18x^2)$$

$$\stackrel{(9)}{=}$$

$$(6x^3)(28x^3) + 126x^6$$

$$\stackrel{(10)}{=}$$

$$168x^6 + 126x^6$$

$$\stackrel{(11)}{=}$$

$$294x^6$$

$$\begin{aligned}
((6x^3)(7x^4))' &\stackrel{(1)}{=} \frac{d}{dx}((6x^3)(7x^4)) \\
&\stackrel{(2)}{=} (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \frac{d}{dx}(6x^3) \\
&\stackrel{(3)}{=} (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot \frac{d}{dx}x^3 \\
&\stackrel{(4)}{=} (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot 3x^2 \\
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&\stackrel{(3)}{=} (6x^3)\frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot \frac{d}{dx}x^3 \\
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&\stackrel{(3)}{=} (6x^3)\frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot \frac{d}{dx}x^3 \\
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((6x^3)(7x^4))' &\stackrel{(1)}{=} \frac{d}{dx}((6x^3)(7x^4)) \\
&\stackrel{(2)}{=} (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \frac{d}{dx}(6x^3) \\
&\stackrel{(3)}{=} (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot \frac{d}{dx}x^3 \quad \text{por [RMC]} \left[\begin{array}{l} c := 6 \\ f(x) := x^3 \end{array} \right] \\
&\stackrel{(4)}{=} (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot 3x^2 \\
&\stackrel{(5)}{=} (6x^3) \frac{d}{dx}(7x^4) + (7x^4)(18x^2) \\
&\stackrel{(6)}{=} (6x^3) \cdot 7 \frac{d}{dx}x^4 + (7x^4)(18x^2) \\
&\stackrel{(7)}{=} (6x^3) \cdot 7 \cdot 4x^3 + (7x^4)(18x^2) \\
&\stackrel{(8)}{=} (6x^3)(28x^3) + (7x^4)(18x^2) \\
&\stackrel{(9)}{=} (6x^3)(28x^3) + 126x^6 \\
&\stackrel{(10)}{=} 168x^6 + 126x^6 \\
&\stackrel{(11)}{=} 294x^6
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&\stackrel{(3)}{=} (6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot \frac{d}{dx}x^3 \quad \text{por} \quad \underbrace{\text{[RMC]}}_{\left(= \frac{\frac{d}{dx}(cf(x))}{c \left(\frac{d}{dx}f(x)\right)} \right)} \quad \left[\begin{array}{l} c := 6 \\ f(x) := x^3 \end{array} \right] \\
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&\stackrel{(4)}{=} \boxed{(6x^3)\frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot 3x^2} \quad \text{por [RPot]} \\
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&\stackrel{(4)}{=} \boxed{(6x^3)\frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot 3x^2} \quad \text{por [RPot] } [n := 3] \\
&\stackrel{(5)}{=} (6x^3)\frac{d}{dx}(7x^4) + (7x^4)(18x^2) \\
&\stackrel{(6)}{=} (6x^3) \cdot 7\frac{d}{dx}x^4 + (7x^4)(18x^2) \\
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&\stackrel{(4)}{=} \boxed{(6x^3) \frac{d}{dx}(7x^4) + (7x^4) \cdot 6 \cdot \boxed{3x^2}} \quad \text{por} \quad \underbrace{\boxed{\text{RPot}}}_{\left(= \frac{\frac{d}{dx}x^n}{n x^{n-1}} \right)} \quad [n := 3] \\
&\stackrel{(5)}{=} (6x^3) \frac{d}{dx}(7x^4) + (7x^4)(18x^2) \\
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&\stackrel{(5)}{=} (6x^3) \left[\frac{d}{dx}(7x^4) \right] + (7x^4)(18x^2) \\
&\stackrel{(6)}{=} (6x^3) \cdot \left[7 \frac{d}{dx}x^4 \right] + (7x^4)(18x^2) \quad \text{por [RMC]} \\
&\stackrel{(7)}{=} (6x^3) \cdot 7 \cdot 4x^3 + (7x^4)(18x^2) \\
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&\stackrel{(6)}{=} (6x^3) \cdot \left[7 \frac{d}{dx}x^4 \right] + (7x^4)(18x^2) \quad \text{por [RMC]} \left[\begin{array}{l} c := 7 \\ f(x) := x^4 \end{array} \right] \\
&\stackrel{(7)}{=} (6x^3) \cdot 7 \cdot 4x^3 + (7x^4)(18x^2) \\
&\stackrel{(8)}{=} (6x^3)(28x^3) + (7x^4)(18x^2) \\
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\end{aligned}
\quad \underbrace{\left(= \frac{\frac{d}{dx}(cf(x))}{c \left(\frac{d}{dx}f(x) \right)} \right)}_{\left(= \frac{\frac{d}{dx}(7x^4)}{7 \left(\frac{d}{dx}x^4 \right)} \right)}$$

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&\stackrel{(7)}{=} (6x^3) \cdot 7 \cdot 4x^3 + (7x^4)(18x^2) \quad \text{por [RPot] } [n := 4] \\
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&\stackrel{(10)}{=} 168x^6 + 126x^6 \\
&\stackrel{(11)}{=} 294x^6 \quad \underbrace{\left(= \frac{\frac{d}{dx} x^4}{4 x^{4-1}} \right)}
\end{aligned}$$