

Do now as a warm-up:

Do you remember how to take the derivative of functions like these?

$$f(x) = (x - 2)(x + 3)$$

$$f(x) = \frac{x + 5}{x - 2}$$

## 2.3 The Product and Quotient Rules

Thm. The Product Rule

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

"each one takes a turn"

$$\frac{d}{dx} [uv] = u'v + uv'$$

ex. Find  $y'$  if  $y = (x^2 + 2x)(x + 1)$

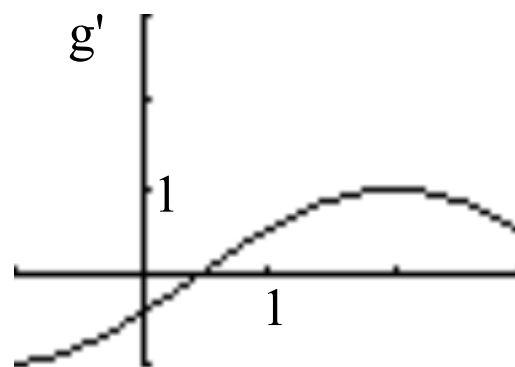
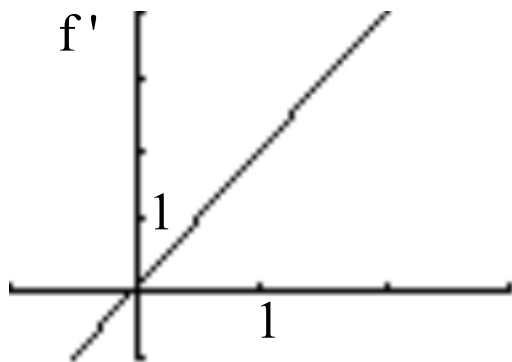
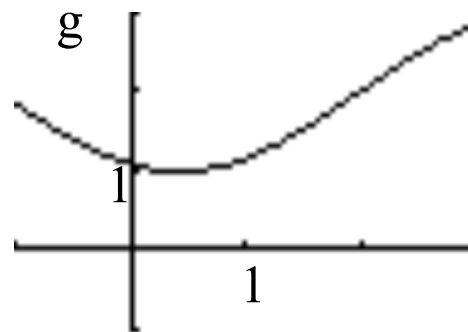
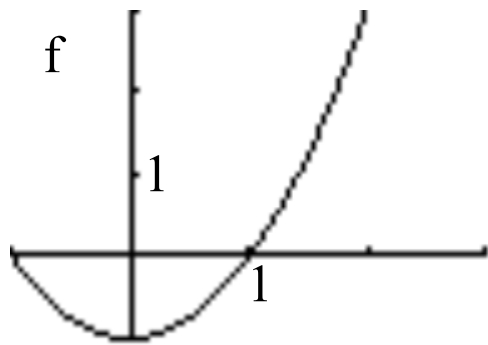
ex. Find  $f'(x)$  if

$$f(x) = (\sin x)\sqrt{x+6}$$

ex. Suppose  $h(x)=f(x)g(x)$ .

Find  $h'(1)$  if  $f(1) = 2$ ,  $f'(1)=-3$ ,  $g(1)=5$ , and  $g'(1)=7$ .

ex. Suppose  $h(x)=f(x)g(x)$ .  
Find  $h'(2)$ .



Thm. The Quotient Rule

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

$$\frac{\text{dnum} \text{denom} - \text{num} \text{ddenom}}{\text{denom} \text{denom}} \quad \frac{\text{low} \text{dhigh} - \text{high} \text{dlow}}{\text{low} \text{low}}$$

$$\frac{d}{dx} \left[ \frac{u}{v} \right] = \frac{u'v - uv'}{v^2}$$

ex. Find the derivative of

$$f(x) = \frac{x^7}{3x - 2}$$

ex. Suppose  $h(x)=f(x)/g(x)$ .

Find  $h'(1)$  if  $f(1) = 2$ ,  $f'(1)=-3$ ,  $g(1)=5$ , and  $g'(1)=7$ .

$$\text{ex. } \frac{d}{dx} \tan x$$

Thm. Derivatives of Trig Functions

$$\frac{d}{dx} \sin x = \cos x$$

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

$$\frac{d}{dx} \tan x = \sec^2 x$$

$$\frac{d}{dx} \cot x = -\csc^2 x$$

$$\frac{d}{dx} \sec x = \sec x \tan x$$

$$\frac{d}{dx} \csc x = -\csc x \cot x$$

$$\text{ex. } \frac{d}{dx}[4\tan x - 3\sec x]$$

ex. Find  $y'$  if  $y = \frac{1 - \cos x}{\sin x}$

**Higher Order Derivatives**

$$\text{1st Derivative} = y'(x) = f'(x) = \frac{dy}{dx} = \frac{d}{dx} [f(x)]$$

$$\text{2nd Derivative} = y''(x) = f''(x) = \frac{d^2y}{dx^2} = \frac{d^2}{dx^2} [f(x)]$$

$$\text{3rd Derivative} = y'''(x) = f'''(x) = \frac{d^3y}{dx^3} = \frac{d^3}{dx^3} [f(x)]$$

$$\text{4th Derivative} = y^{(4)}(x)$$

$$\text{5th Derivative} = y^{(5)}(x)$$

*etc.*

## Derivative on the calculator

ex. Find the slope of the curve at  $x=2$  for the function  $y=x^2-3x+1$

2nd TRACE 6:  $dy/dx$

Push 2

Push ENTER

MATH

8: nDeriv(

enter this:  $x^2-3x+1,x,2$

nDeriv(expression, variable, value)