3a) $2x^2 - x - 3$ at $(2,3)$

find equation of normal line

gradient $= \frac{-1}{m}$

$f'(x) = 4x - 1$

$f'(2) = 4(2) - 1 = 8 - 1 = 7$

$y - y_1 = m(x - x_1)$

$y - 3 = -\frac{1}{7}(x - 2)$

3d. $f(x) = 2\sqrt[3]{x} - \frac{4}{x^2}$ at $x = 1$

$f(1) = 2\sqrt[3]{1} - \frac{4}{1^2}$ point $(1, -2)$

$= 2 - 4 = -2$

$f(x) = 2x^{\frac{1}{3}} - 4x^{-2}$

$f'(x) = \frac{2}{3}x^{-\frac{2}{3}} + 8x^{-3}$

$f'(1) = \frac{2}{3} + 8 = \frac{2}{3} + \frac{24}{3} = \frac{26}{3}$

$y + 2 = -\frac{3}{26}(x - 1)$

5. $f(x) = 2x^2 + Kx - 3$ and $f'(-1) = 1$

$f'(x) = 4x + K$

$1 = 4(-1) + K$

$1 = -4 + K$

$5 = K$

7.3 More Rules for derivatives

Graph $y = e^x$ on calculator - use calculator to find y' or $\frac{dy}{dx}$ at a given x

x	$y=e^x$	$\frac{dy}{dx}$ e^x
-2		0.1353
-1		
0		
1		
2		
3		

Derivative of e^x

If $f(x) = e^x$,

then $f'(x) = e^x$

Ex $f(x) = 3e^x$

$f'(x) = 3 \cdot e^x$

$= 3e^x$

$y = \ln x$

relationship?

x	$y = \ln x$	$\frac{dy}{dx}$	
$\cancel{0}$		1	
1	0		$\frac{1}{1}$
3	1.09	0.333	$\frac{1}{3}$
4	1.38	0.25	$\frac{1}{4}$
10	2.302	0.1	$\frac{1}{10}$

if $f(x) = \ln x$

then $f'(x) = \frac{1}{x}$

$\boxed{\text{Ex}}$ $f(x) = \ln(3)$

$f'(x) = \frac{1}{3}$

$\boxed{\text{Ex}}$ $f(x) = \ln e^{3x}$

$f(x) = 3x$

$f'(x) = 3$

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Investigate the derivative of the product of 2 functions

*Recall if $f(x) = u(x) + v(x)$, then
$$f'(x) = u'(x) + v'(x)$$

Is this true:

$$f(x) = u(x) \cdot v(x) \text{ then}$$
$$f'(x) = u'(x) \cdot v'(x) ?$$

Ex) $u(x) = x^4$, $v(x) = x^7$

and $f(x) = u(x) \cdot v(x)$, so $f(x) = x^{11}$

① $f'(x) = 11x^{10}$ $\quad 11x^{10} \stackrel{?}{=} (4x^3)(7x^6)$

② $u'(x) = 4x^3$

③ $v'(x) = 7x^6$.

$$f'(x) = x^4 \cdot \underline{7x^6} + x^7 \cdot \underline{4x^3} = \underline{11x^{10}}$$

The Product Rule

if $f(x) = u(x) \cdot v(x)$, then

$$f'(x) = \underbrace{u(x)}_{\text{1st}} \cdot \underbrace{v'(x)}_{\text{der 2nd}} + \underbrace{v(x)}_{\text{2nd}} \cdot \underbrace{u'(x)}_{\text{der 1st}}$$

Ex/ $f(x) = (3x+1)(\ln x)$

$$f'(x) = (3x+1)\left(\frac{1}{x}\right) + (\ln x)(3)$$

$$f'(x) = 3 + \frac{1}{x} + 3\ln x$$

Ex 2| $f(x) = (x^4+3x^3+6)(2x-1)$

$f'(x) = (x^4+3x^3+6)(2) + (2x-1)(4x^3+9x^2)$

$f'(x) = 10x^4+20x^3-9x^2+12$

The Quotient Rule

if $f(x) = \dfrac{u(x)}{v(x)}$ then $f'(x) = \dfrac{v(x)\cdot u'(x) - u(x)v'(x)}{[v(x)]^2}$

Ex| $f(x) = \dfrac{5x+3}{x^2+1}$ $= \dfrac{\text{bottom} \cdot \text{dertop} - \text{top} \cdot \text{der}_{\text{bottom}}}{\text{bottom}^2}$

$$f'(x) = \frac{(x^2+1)(5) - (5x+3)(2x)}{(x^2+1)^2}$$

... Algebra Happens ...

$$= \frac{-5x^2+6x+5}{(x^2+1)^2}$$

Ex) $f(x) = \dfrac{x+2}{2e^x - 3}$

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

$$= \frac{2e^x - 3 - 2xe^x - 4e^x}{(2e^x-3)^2}$$

$$f'(x) = \frac{-2e^x - 3 - 2xe^x}{(2e^x-3)^2}$$

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