Warm Up

Use first principles to find the derivative of $y = b^x$

$$\frac{dy}{dx} = \lim_{h \to 0} \frac{b^{(x+h)} - b^x}{h}$$

$$\frac{dy}{dx} = \lim_{h \to 0} \frac{b^x(b^h - 1)}{h}$$

$$\frac{dy}{dx} = b^x \lim_{h \to 0} \frac{b^h - 1}{h}$$

Find the derivative of $f(x) = 2^x$. $f'(x) = 2^x \lim_{h \to 0}\left(\frac{2^h - 1}{h}\right)$ =

h	$\frac{2^h-1}{h}$
3	$\frac{7}{3} = 2.333\ldots$
2	$\frac{3}{2} = 1.5$
1	$\frac{1}{1} = 1$
0.5	0.82843
0.2	0.74349
0.1	0.7177346
0.01	0.69556
0.001	0.69339
0.0001	0.69317

$\therefore f'(x) = 0.693(2^x)$

Find the derivative of $f(x) = 3^x$. $f'(x) = 3^x \lim_{h \to 0}\left(\frac{3^h - 1}{h}\right) = 1.09(3^x)$

h	$\frac{3^h - 1}{h}$
1	2
0.1	1.16123
0.01	1.104669
0.001	1.099215
0.0001	1.098672

$$\frac{de^x}{dx} = e^x$$

What b will have $\lim_{h\to 0}\left(\frac{b^h - 1}{h}\right) = 1$, so that $f'(x) = b^x$.

b	$\frac{b^{.0001} - 1}{.0001}$
2.5	0.916
2.75	1.0116
2.7	0.9933
2.72	1.00068
2.715	0.9988
e	1

Example #1

Differentiate

a) $y = 5e^x$

$\frac{dy}{dx} = 5e^x$

b) $y = e^{-x}$

$\frac{dy}{dx} = -e^{-x}$

c) $y = xe^x$

$\frac{dy}{dx} = e^x + xe^x$

$\frac{dy}{dx} = e^x(1+x)$

$y'' = e^x(1+x) + e^x$

$= e^x(1+x+1)$

$= e^x(x+2)$

d) $y = e^{x^2}$

$\frac{dy}{dx} = 2xe^{x^2}$