5. $f(x) = \sqrt{e^{2x} + e^{-2x}} = \left(e^{2x} + e^{-2x}\right)^{1/2}$

$$f'(x) = \frac{1}{2}\left(e^{2x} + e^{-2x}\right)^{-\frac{1}{2}}\left[e^{2x} \cdot 2 + e^{-2x}(-2)\right] \qquad \frac{d}{du}u^n = nu^{n-1}$$

$$= \frac{2e^{2x} - 2e^{-2x}}{2\sqrt{e^{2x} + e^{-2x}}} = \frac{e^{2x} - e^{-2x}}{\sqrt{e^{2x} + e^{-2x}}}$$

6. $f(x) = \ln(1 - 2x^3)$

$$f'(x) = \frac{1}{(1-2x^3)}\left(-6x^2\right) = \frac{-6x^2}{(1-2x^3)}$$

7. $f(x) = \ln(\ln(x^2))$

$$f'(x) = \frac{1}{\ln(x^2)} \cdot \frac{1}{\cancel{x^2}} \cdot 2\cancel{x}$$

$$= \frac{2}{x\ln(x^2)} = \frac{\cancel{2}}{x(\cancel{2}\ln x)}$$

$$= \frac{1}{x\ln x}$$

12) $f(x) = x^3 \ln x$

$= x^3\left(\frac{1}{x}\right) + \ln x\,(3x^2)$

$0 = x^2 + 3x^2 \ln x$

$0 = x^2(1 + 3\ln x)$

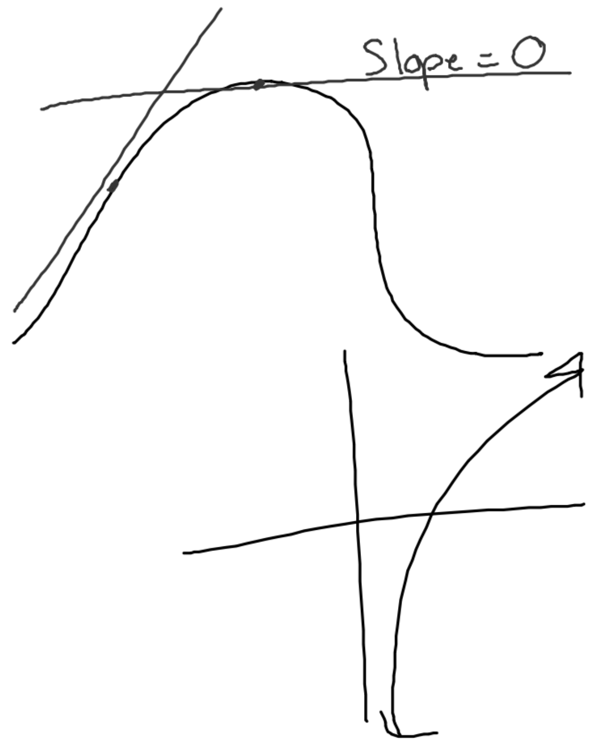
$x^2 = 0$ or $1 + 3\ln x = 0$

$x = 0$ $\quad 3\ln x = -1$

$\ln x = -\frac{1}{3}$

$\cancel{e}^{\cancel{\ln} x} = e^{-\frac{1}{3}}$

$x = e^{-\frac{1}{3}} \approx 0.717$



13) $f(x) = x^{-3}$, $g(x) = 1-2x$ $\quad h(x) = (f \circ g)(x)$

$$= f(g(x))$$

$$h = f(1-2x) = (1-2x)^{-3}$$

$$h' = -3(1-2x)^{-4}(-2)$$

$$= \frac{6}{(1-2x)^4}$$

$6 > 0$, since the denominator is raised to an even power, there exists no real value of x for which $h(x) < 0$

Higher Order Derivatives

$f'(x) = \frac{dy}{dx}$ is called the first derivative of y with respect to x (gradient of tangent line at x)

- the 1st derivative is generally a function, As such we could find the gradient of this function at x.

$$f''(x) = \frac{d^2y}{dx^2}$$ "f double prime"

- we can continue until derivative is 0

$$f'(x) = \frac{dy}{dx} \qquad f^{(n)} = \frac{d^n y}{dx^n}$$

$$f''(x) = \frac{d^2y}{dx^2}$$

$$f'''(x) = \frac{d^3y}{dx^3}$$

Ex) Find the 1st 2 derivatives of

$$f(x) = x^4 + 3x^2 + x$$

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

$$f''(x) = 12x^2 + 6$$

Ex) $f'(x) = \sqrt{x^2+4}$; find $f''(x)$

$$= (x^2+4)^{1/2}$$

$$f''(x) = \frac{1}{\cancel{2}}(x^2+4)^{-\frac{1}{2}} \cdot \cancel{2}x$$

$$= \frac{x}{\sqrt{x^2+4}}$$

$\underline{\boxed{Ex}}$ $y = 4e^{2x}$ find $\frac{d^3 y}{dx^3}$

$$\frac{dy}{dx} = 4e^{2x} \cdot 2 = 8e^{2x}$$

$$\frac{d^2y}{dx^2} = 8e^{2x} \cdot 2 = 16e^{2x}$$

$$\frac{d^3y}{dx^3} = 16e^{2x} \cdot 2 = 32e^{2x}$$

$$\left.\frac{d^3y}{dx^3}\right|_{x=4}$$

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