

$$2 \int \frac{dx}{x^2+36}$$

$$\text{let } u = (x^2+36)$$

$$\frac{du}{dx} = 2x \Rightarrow dx = \frac{du}{2x}$$

$$\int \frac{dx}{(x^2+36)} = \int \frac{1}{u} \left( \frac{du}{2x} \right) = \frac{1}{2x} \int \frac{du}{u}$$

$$= \frac{1}{2x} \left[ \frac{u^2}{2} \right] + 2$$

$$= \frac{1}{4x} \left[ \frac{u^2}{2} \right] + 2$$

$$= \frac{1}{4x} (x^2+36)^2 + C$$

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$$\int \frac{dx}{(x^2+13)}$$

$$\text{let } u = (x^2+13)$$

$$\frac{du}{dx} = 2x$$

$$dx = \frac{du}{2x}$$

$$\int \frac{dx}{(x^2+13)} = \int \frac{1}{u} \left( \frac{du}{2x} \right) \Rightarrow \frac{1}{2} \int \frac{du}{u}$$

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Assignment

$$\textcircled{1} \quad y = \sin\left(\frac{3}{x^2}\right)$$

$$y + \Delta y = \sin\left[\frac{3}{(x + \Delta x)^2}\right] - y$$

$$\Delta y = \sin\left[\frac{3}{(x + \Delta x)^2}\right] - y$$

$$\Delta y = \sin\left[\frac{3}{(x + \Delta x)^2}\right] - \sin\left[\frac{3}{x^2}\right] \quad \text{--- (1)}$$

Recall,  $\sin A - \sin B = 2 \cos\left(\frac{A+B}{2}\right) \sin\left(\frac{A-B}{2}\right)$  --- (2)

Comparing equation (1) & (2)

$$A = \frac{3}{(x + \Delta x)^2} \quad \text{and} \quad B = \frac{3}{x^2}$$

$$\frac{A+B}{2} = \frac{\frac{3}{(x + \Delta x)^2} + \frac{3}{x^2}}{2}$$

$$\Rightarrow \frac{3x^2 + 3(x + \Delta x)^2}{(x + \Delta x)^2 (x^2)} = 2$$

$$\Rightarrow \frac{3x^2 + 3(x + \Delta x)x + \Delta x}{(x + \Delta x)(x)^2} = 2$$

$$\Rightarrow \frac{3x^2 + 3x^2 + 3\Delta x(x + \Delta x)}{(x + \Delta x)^2 (x^2)} = 2$$

$$\Rightarrow \frac{3x^2 + 3x^2 + 3x\Delta x + 3x\Delta x + 3(\Delta x)^2}{(x + \Delta x)^2 (x^2)} = 2$$

$$\Rightarrow \frac{9x^2 + 9x\Delta x + 3(\Delta x)^2}{(x + \Delta x)(x^2)} \times \frac{1}{2}$$

$$\Rightarrow \frac{9x^2 + 9x\Delta x + 3(\Delta x)^2}{2(x + \Delta x)^2 (x^2)}$$

(19) Continuation

$$\frac{\Delta y}{\Delta x} = \frac{3}{(x+\Delta x)^2} - \frac{3}{x^2}$$

$$\frac{3x^2 - 3(x+\Delta x)^2}{(x+\Delta x)^2 (x^2)}$$

$$= \frac{3x^2 - 3(x^2 + 2x\Delta x + \Delta x^2)}{(x+\Delta x)^2 (x^2)}$$

$$= \frac{3x^2 - (3x^2 + 6x\Delta x + 3\Delta x^2)}{(x+\Delta x)^2 (x^2)}$$

$$= \frac{3x^2 - 3x^2 - 6x\Delta x - 3\Delta x^2}{(x+\Delta x)^2 (x^2)}$$

$$= \frac{-6x\Delta x - 3\Delta x^2}{(x+\Delta x)^2 (x^2)}$$

Hence  $\sin \left[ \frac{3}{(x+\Delta x)^2} \right] - \sin \left[ \frac{3}{x^2} \right]$

$$= \frac{2 \cos \left[ \frac{9x^2 + 9x\Delta x + 3(\Delta x)^2}{2(x+\Delta x)^2 (x^2)} \right] \sin \left[ \frac{9x\Delta x - 3(\Delta x)^2}{2(x+\Delta x)^2 (x^2)} \right]}{1}$$

Divide through by  $\Delta x$

$$= \frac{2 \cos \left[ \frac{9x + 9x\Delta x + 3(\Delta x)^2}{2(x+\Delta x)^2 (x^2)} \right] \sin \left[ \frac{-9x\Delta x - 3(\Delta x)^2}{2(x+\Delta x)^2 (x^2)} \right]}{1}$$

$$\cos \left[ \frac{9x^2 + 0 + 0}{2x^4} \right] \sin \left[ \frac{0}{2x^4} \right] \Big|_{\Delta x \rightarrow 0} \frac{x}{x/2}$$

Hence  $\frac{dy}{dx} = \cos \frac{9x^2}{2x^4}$

~~Not  $\Delta y = \frac{4}{x^2} \Delta x$~~

⑤

$$y = \frac{4}{x^2}$$

$$y + \Delta y = \frac{4}{(x + \Delta x)^2}$$

$$\Delta y = \frac{4}{x^2 + 3x^2 \Delta x + 3x(\Delta x)^2 + \Delta x^3} - \frac{4}{x^2}$$

$$= \frac{4}{x^2 + 3x^2 \Delta x + 3x(\Delta x)^2 + \Delta x^3} - \frac{4}{x^2}$$

$$= \frac{4}{x^2 + 3x^2 \Delta x + 3x(\Delta x)^2 + \Delta x^3} - \frac{4}{x^2}$$

$$= \frac{4x^2 - (x^2 + 3x^2 \Delta x + 3x(\Delta x)^2 + \Delta x^3)}{(x^2 + 3x^2 \Delta x + 3x(\Delta x)^2 + \Delta x^3)x^2}$$

$$= \frac{4x^2 - x^2 - 3x^2 \Delta x - 3x(\Delta x)^2 - \Delta x^3}{(x^2 + 3x^2 \Delta x + 3x(\Delta x)^2 + \Delta x^3)x^2}$$

$$= \frac{4x^2 - x^2 - 3x^2 \Delta x - 3x(\Delta x)^2 - \Delta x^3}{(x^2 + 3x^2 \Delta x + 3x(\Delta x)^2 + \Delta x^3)x^2}$$

Divide both side by  $\Delta x$

$$= \frac{4(-3x^2 \Delta x - 3x(\Delta x)^2 - \Delta x^3)}{(x^2 + 3x^2 \Delta x + 3x(\Delta x)^2 + \Delta x^3)x^2} \cdot \frac{\Delta x}{\Delta x}$$

$$= \frac{4(-3x^2 \Delta x - 3x(\Delta x)^2 - \Delta x^3)}{(x^2 + 3x^2 \Delta x + 3x(\Delta x)^2 + \Delta x^3)x^2} \cdot \frac{1}{\Delta x}$$

$$= \frac{4(-3x^2 - 3x\Delta x - \Delta x^2)}{(x^2 + 3x^2(\Delta x + 3x(\Delta x)^2 + \Delta x^3))x^2} \cdot \frac{1}{\Delta x}$$

$$\frac{\Delta y}{\Delta x} = \frac{4(-3x^2 - 3x\Delta x - \Delta x^2)}{x^2 + 3x^2 \Delta x + 3x(\Delta x)^2 + \Delta x^3}$$

Lim  $\Delta x \rightarrow 0$

$$\frac{\Delta y}{\Delta x} = \frac{4(-3x^2)}{(x^2 + 0)x^2}$$