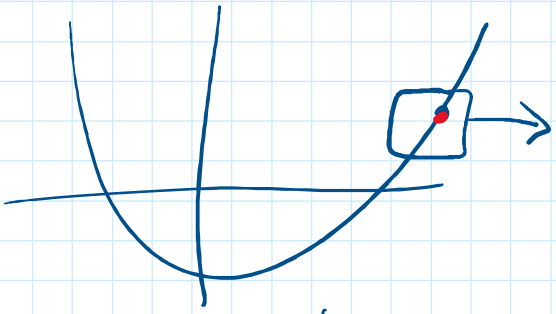
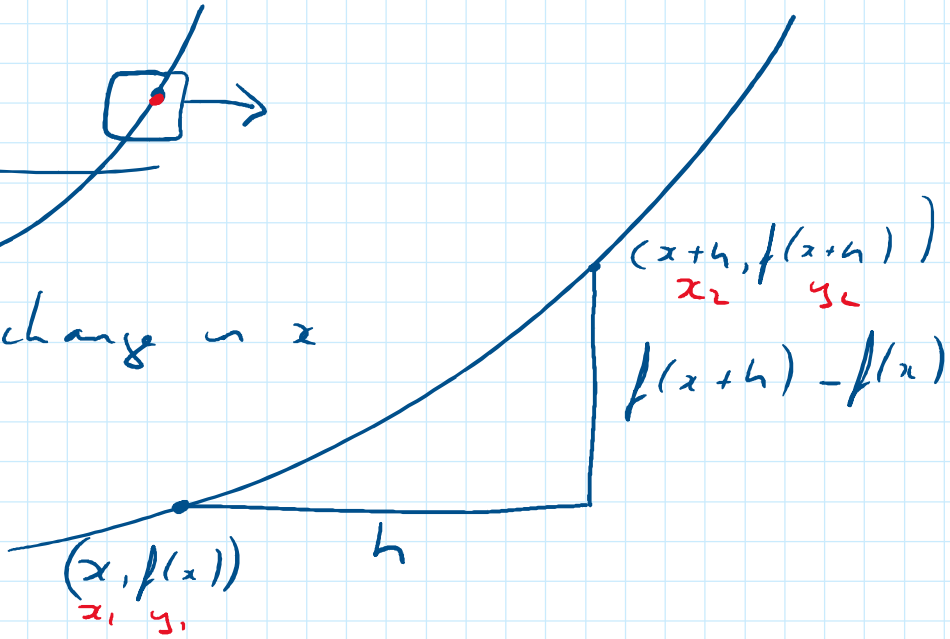
Differentiation from First principals



h = small change in x



Rate of change of y with a change in x

$$\frac{dy}{dx} = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h} = \frac{y_2 - y_1}{x_2 - x_1} = m$$

$f(x) = x^2$ differentiate from 1st principals.

$$f(x+h) = (x+h)^2$$
$$= x^2 + 2xh + h^2$$

$$f(x+h) - f(x) = 2xh + h^2$$

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

$$\lim_{h \to 0} \frac{f(x+h) - f(x)}{h} = 2x$$

$$y = x^2 \qquad \frac{dy}{dx} = 2x$$

Learn Left Hand Side

Differentiate $f(x) = 3x + 7$ from first principals.

Change x Start $(x, f(x))$ Next $(x+h, f(x+h))$

$$f(x) = 3x + 7$$

$$f(x+h) = 3(x+h) + 7$$

$$= 3x + 3h + 7$$

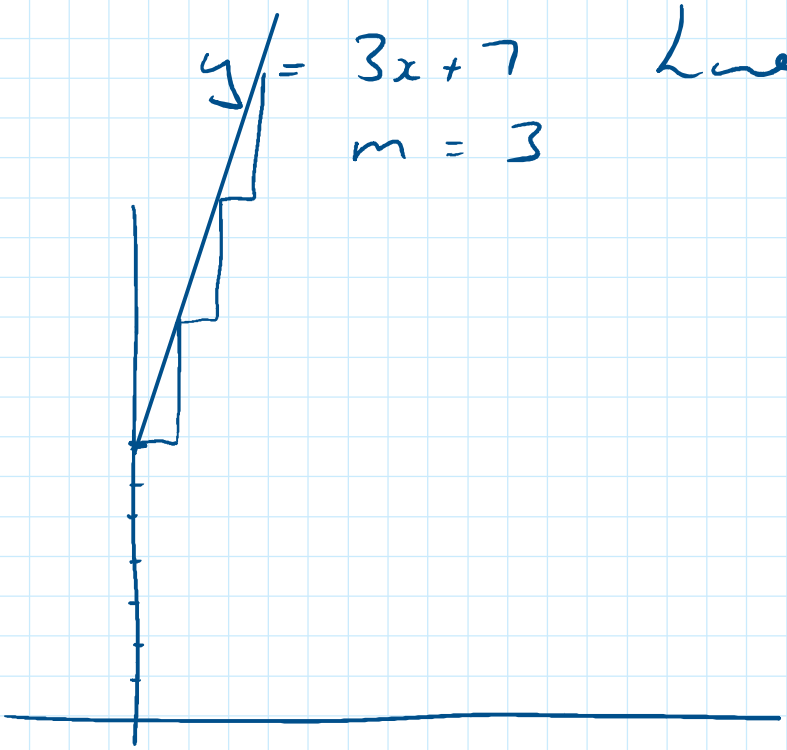
$$f(x+h) - f(x) = 3h$$

$$\frac{f(x+h) - f(x)}{h} = 3$$

$$\lim_{h \to 0} \frac{f(x+h) - f(x)}{h} = 3$$

$y = 3x + 7$ Line

$m = 3$



$$f(x) = x^2 + 5x + 3$$

$$f(x+h) = (x+h)^2 + 5(x+h) + 3$$

$$= x^2 + 2xh + h^2 + 5x + 5h + 3$$

$$f(x+h) - f(x) = 2xh + h^2 + 5h$$

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

$$\lim_{h \to 0} \frac{f(x+h) - f(x)}{h} = 2x + 5$$

$x^2 \Rightarrow 2x$

$3x \Rightarrow 3$

$7 \Rightarrow 0$

$$y = x^3$$

$$\frac{dy}{dx} = 3x^2$$

$$y = x^4$$

$$\frac{dy}{dx} = 4x^3$$