

**Example 1**

Differentiate  $f(x) = 3x + 8$  from first principles.

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

$$f(x) = 3x + 8$$

$$f(x+h) = 3(x+h) + 8 = 3x + 3h + 8$$

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

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

$$\underbrace{f'(x)}_{\text{derivative}} = 3$$

**Example 2**

Differentiate  $f(x) = x^2 - 6x$  from first principles.

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

$$f(x+h) = (x+h)^2 - 6(x+h)$$

$$= x^2 + 2xh + h^2 - 6x - 6h$$

$$- f(x) = -x^2 + 6x$$

$$\frac{f(x+h) - f(x)}{h} = \frac{2x\cancel{h} + h^{\cancel{x}} - 6\cancel{h}}{\cancel{h}} = 2x + h - 6$$

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h} = 2x + 0 - 6 = 2x - 6$$