

Differentiation is used to find the gradient of a tangent to a curve.

While the gradient of a straight line is constant, for a curve, the gradient is always changing.

The gradient of a curve at a given point is defined as being the gradient of the tangent at that point.

The function that tells us the gradient of the tangent and curve at the given point is called the derivative.

The formal technique for finding the gradient of a tangent is known as differentiation from first principles and is written as:

$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$, where h is the horizontal distance between two points on the curve and has a limit tending to zero.

Using differentiation from first principles, differentiate $f(x) = x^2$.

Substitute $f(x) = x^2$, which gives $\frac{(x+h)^2 - x^2}{h}$, subtract x^2 divided by h .

Multiply out the brackets to get $\frac{x^2 + 2xh + h^2 - x^2}{h}$, subtract x^2 , all over h .

Gather like terms and simplify $\frac{2xh + h^2}{h}$, which is $2x + h$, divided by h .

This gives the answer $2x + h$. As h tends to zero, the derivative $f'(x) = 2x$.