= 2 , f (2) =
4 , and so on .

= = = Higher derivatives = = =

Let f be a differentiable function , and let f ? (x) be its derivative . The derivative of f ? (x) (if it has one) is written f ? ? (x) and is called the second derivative of f . Similarly , the derivative of a second derivative , if it exists , is written f ? ? ? (x) and is called the third derivative of f . Continuing this process , one can define , if it exists , the nth derivative as the derivative of the (n @-@ 1) th derivative . These repeated derivatives are called higher @-@ order derivatives . The nth derivative is also called the derivative of order n .

If x (t) represents the position of an object at time t , then the higher @-@ order derivatives of x have physical interpretations . The second derivative of x is the derivative of x ? (t) , the velocity , and by definition this is the object 's acceleration . The third derivative of x is defined to be the jerk , and the fourth derivative is defined to be the jounce .

A function f need not have a derivative , for example , if it is not continuous . Similarly , even if f does have a derivative , it may not have a second derivative . For example , let

<formula>

Calculation shows that f is a differentiable function whose derivative is

<formula>

f ? (x) is twice the absolute value function , and it does not have a derivative at zero . Similar examples show that a function can have k derivatives for any non @-@ negative integer k but no (k + 1) th @-@ order derivative . A function that has k successive derivatives is called k times differentiable . If in addition the kth derivative is continuous , then the function is said to be of differentiability class Ck . (This is a stronger condition than having k derivatives . For an example , see differentiability class .) A function that has infinitely many derivatives is called infinitely differentiable or smooth .

On the real line , every polynomial function is infinitely differentiable . By standard differentiation rules , if a polynomial of degree n is differentiated n times , then it becomes a constant function . All of its subsequent derivatives are identically zero . In particular , they exist , so polynomials are smooth functions .

The derivatives of a function f at a point x provide polynomial approximations to that function near x . For example , if f is twice differentiable , then

<formula>

in the sense that

<formula>

If f is infinitely differentiable , then this is the beginning of the Taylor series for f evaluated at x + h around x .

= = = Inflection point = = =