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## 19. Summary

### Secant lines

The **secant line** of a function  $f(x)$  over the interval  $a \leq x \leq b$ , is the line that passes through the points  $(a, f(a))$  and  $(b, f(b))$ .

- The slope of the secant line is  $\frac{f(b) - f(a)}{b - a}$ , which is the average rate of change of the function  $f(x)$  over the interval  $a \leq x \leq b$ .
- The equation for the secant line is  $y = \frac{f(b) - f(a)}{b - a}(x - a) + f(a)$ .

### Tangent lines

The **tangent line** to a function  $f(x)$  at the point  $x = a$  is the line that passes through the point  $(a, f(a))$ , and whose slope is the instantaneous rate of change of  $f(x)$  at the point  $x = a$ . This slope is the slope of the line you get if you imagine zooming in on the function until it looks like a line.

- The slope of the tangent line is  $f'(a)$ .
- The equation for the tangent line is  $y = f'(a)(x - a) + f(a)$ .

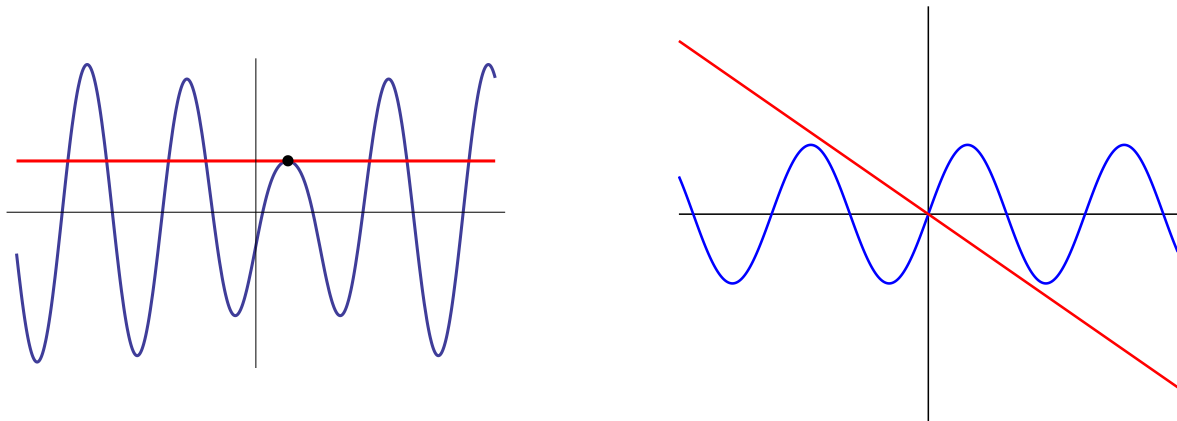
### Properties of tangent lines



If the derivative of  $f(x)$  exists at  $x = a$ , then the tangent line exists. The tangent line may exist if the derivative is undefined at  $x = a$  though. (Example  $f(x) = \sqrt[3]{x}$  has a vertical tangent line at  $x = 0$ .)

### What a tangent line is, and is not

When introduced to tangent lines of circles, many students learn that a tangent is “a line that touches the curve in only one point.” This is true if your curve is a circle, but for many other curves and functions, this is a **terrible** definition. See the examples below.



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? [The last graph in "What a tangent line is not"](#)

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