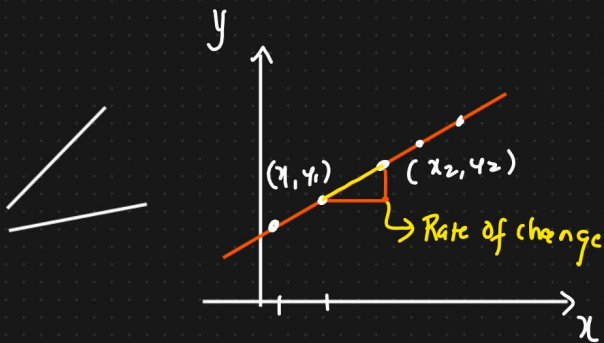


## Slope → Derivative As a Concept

The **slope** of a line is a measure of how steep the line is, and it represents the rate of change of one variable with respect to another. In the context of a two-dimensional Cartesian coordinate system, the slope indicates the ratio of the vertical change (rise) to the horizontal change (run) between two points on a line.



$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\Delta y}{\Delta x} = \frac{\text{Rise}}{\text{Run}}$$

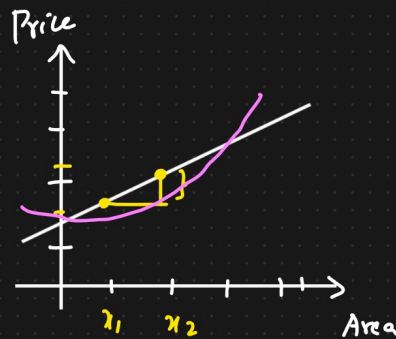
Where  $y_2 - y_1$  is the vertical (rise)  
 $x_2 - x_1$  is the horizontal (run)

Since the line is straight

Rate of change = same = constant

### Dataset

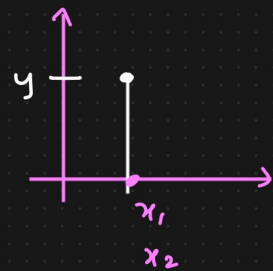
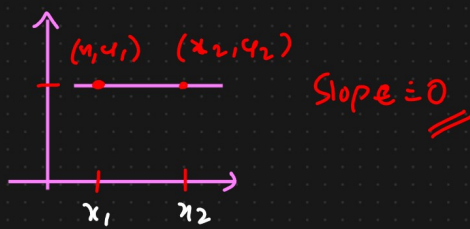
Area      Price



### Interpretation of slope

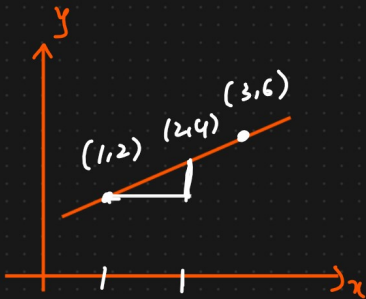
- ⊕ Positive slope: if  $\text{slope} > 0$ , the line rises as it moves from left to right; The larger the slope, the steeper the line.
- ⊖ Negative slope: if  $\text{slope} < 0$ , the line falls as it moves from left to right, the more negative the slope, the steeper the line in the downward direction.
- ⊙ Zero slope: if  $\text{slope} = 0$ , the line is horizontal, meaning there is no vertical change as the line moves from left to right.





Ⓐ Undefined Slope : If  $x_2 = x_1$ , the line is vertical, and the slope is undefined because you cannot divide by 0.

### Examples



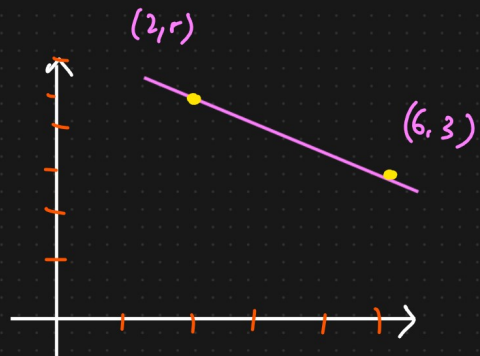
$$\text{Slope} = \frac{6-2}{3-1} = \frac{4}{2} = 2$$

This means that for every unit you move horizontally from left to right the line moves 2 units vertically up.

### 2) Negative Slope

$(2, 5)$   $(6, 3)$

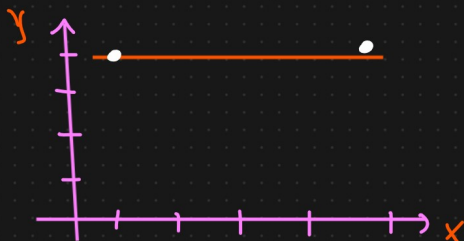
$$\text{Slope} = \frac{3-5}{6-2} = \frac{-2}{4} = -\frac{1}{2} //$$



This means that for every 2 units you move horizontally to the right, the line moves 1 unit vertically down.

### 3) Zero Slope : Consider the points $(1, 4)$ $(5, 4)$

$x$  is not related to  $y$



$$\text{Slope} = \frac{4-4}{5-1} = \frac{0}{4} = 0$$

The mean line is horizontal

④ Undefined Slope

(3,2) (3,7)

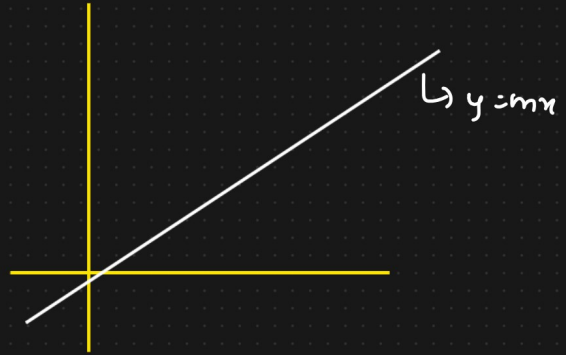
$$\text{slope} = \frac{7-2}{3-3} = \frac{5}{0}$$

b=0

Slope in a Equation of a line

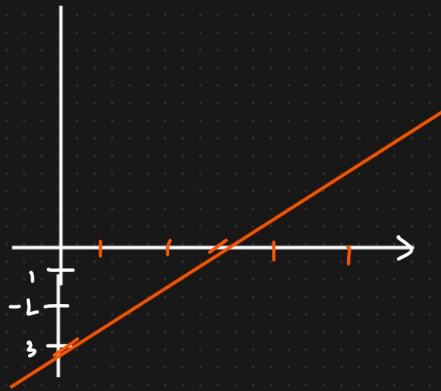
$$y = mx + b$$

- m is the slope of line
- b is the y intercept where the line crosses the y axis

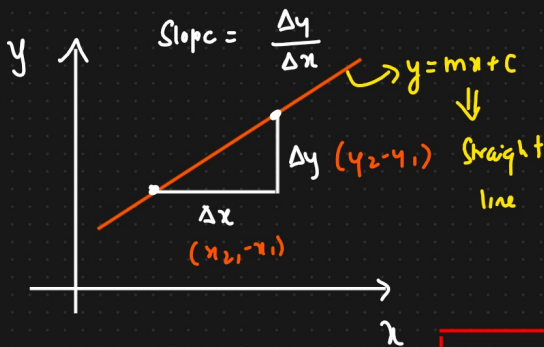


m=2      b=-3

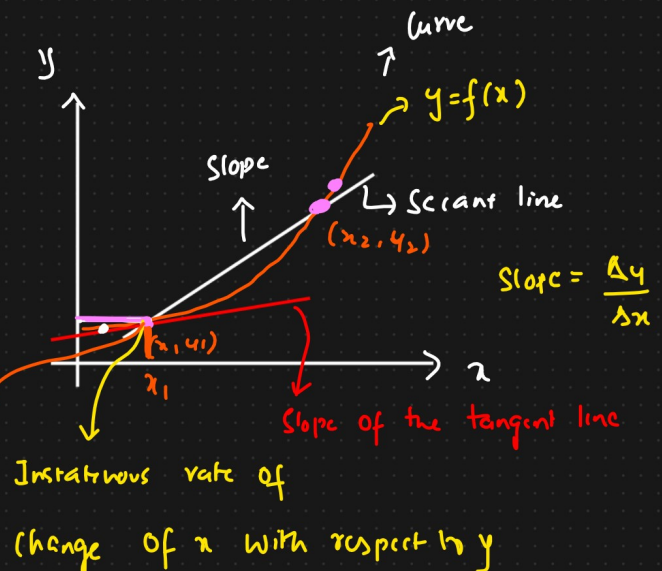
$$\Rightarrow \boxed{y = 2x - 3}$$

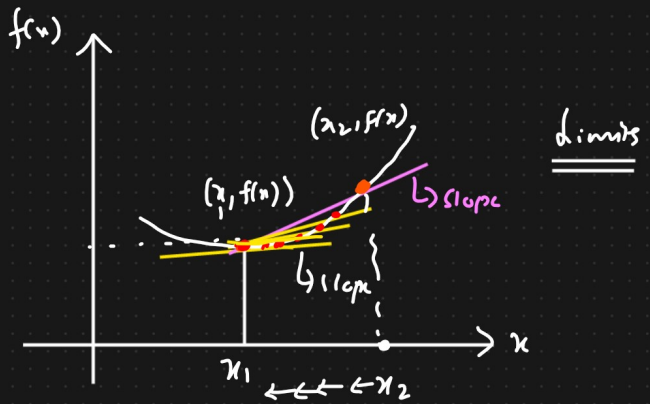
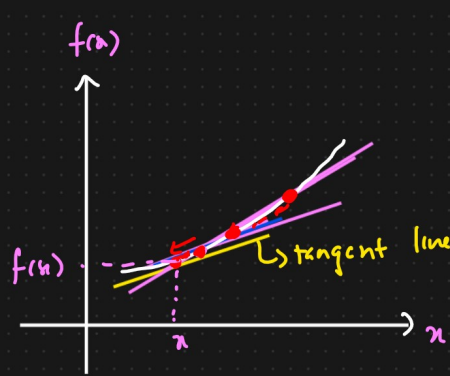


Derivative



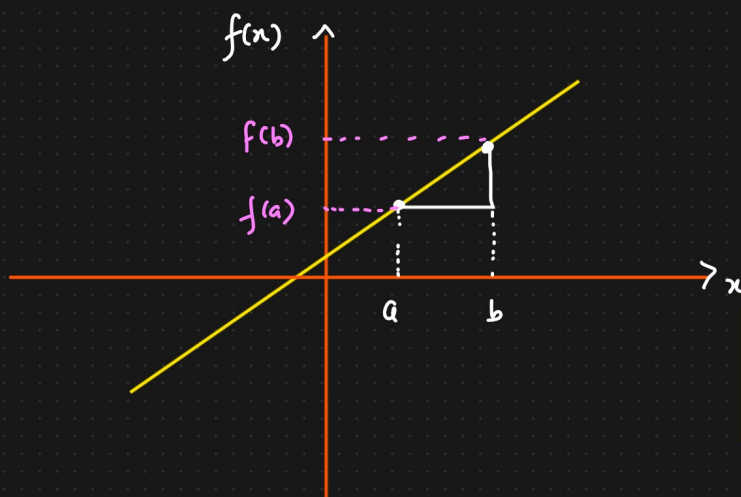
$$\boxed{\text{Slope} = \frac{\partial y}{\partial x}}$$





## Mathematical Notation of Derivative With Limits

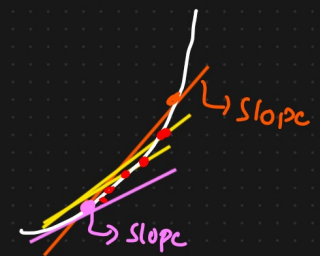
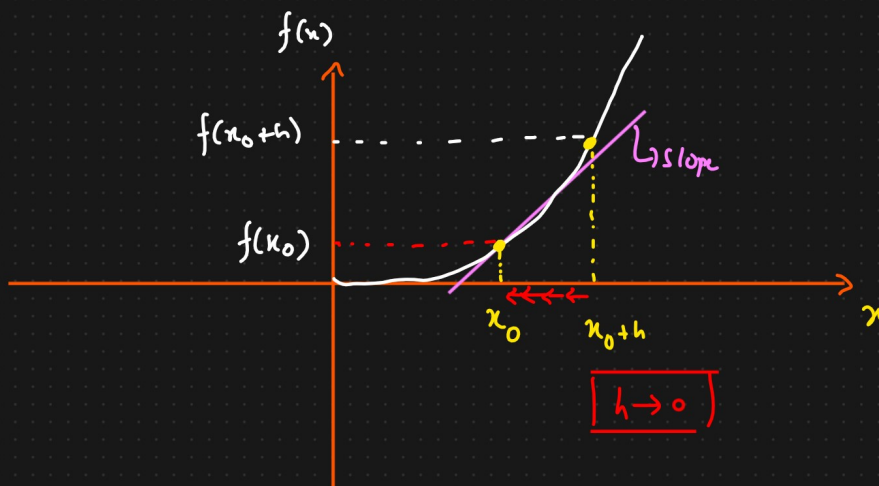
The derivative is a fundamental concept in calculus that represents the rate at which a function is changing at any given point. It is essentially the slope of the tangent line to the function's graph at that point. The derivative is used to understand how a function behaves as its input changes, and it is a key tool for analyzing the dynamics of systems in mathematics, physics, economics, engineering, and many other fields.



$$f(x) = mx + c \quad m \rightarrow \text{slope} \\ c \rightarrow \text{intercept}$$

$$\text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$\frac{\Delta y}{\Delta x} = \frac{f(b) - f(a)}{b - a}$$



Secant line slope is going to give the average rate of change.

$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{f(x_0 + h) - f(x_0)}{(x_0 + h) - x_0} = \frac{\Delta y}{\Delta x}$$

$$\text{Slope of Secant line} = \frac{f(x_0+h) - f(x_0)}{h}$$

$$\lim_{h \rightarrow 0}$$

$$f'(x) =$$

$$\lim_{h \rightarrow 0} \frac{f(x_0+h) - f(x_0)}{h}$$

Derivative of  $f(x)$

$$f'(x) = \frac{\partial y}{\partial x} = \frac{\partial(f(x))}{\partial x} //$$