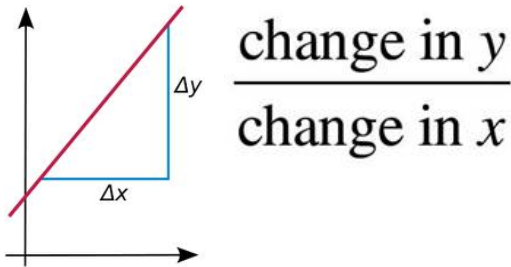


## Slope (Gradient) of a line

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## What is a Slope (Gradient)?

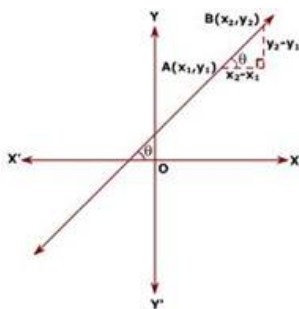


The [slope of a line](#) is a number that measures its "steepness". It is the change in  $y$  for a unit change in  $x$  along the line.

The slope of a line is generally denoted by  $m$ .

Thus,

$$m = \tan \theta$$

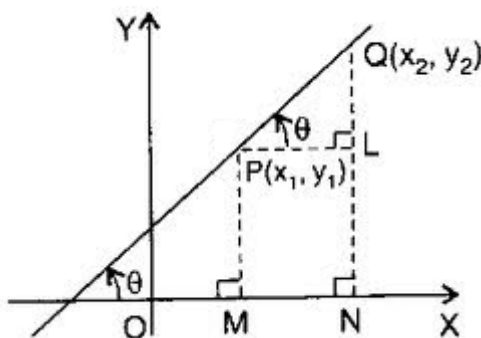


Since a line parallel to  $x$  – axis makes an angle of  $0^\circ$  with  $x$  – axis, therefore its slope is  $\tan 0^\circ = 0$ .

A line parallel to  $y$  – axis, [perpendicular](#) to  $x$  – axis makes an angle of  $90^\circ$  with  $x$  – axis, so its slope is  $\tan 90^\circ = \infty$ . Also, the slope of a line equally inclined with axes is 1 or -1 as it makes  $45^\circ$  or  $135^\circ$  with  $x$  – axis.

The angle of inclination of a line with the positive direction of  $x$  – axis in anticlockwise sense always lies between  $0^\circ$  and  $180^\circ$ .

## Slope of a line in terms of coordinates of any two points on it



Let  $P(x_1, y_1)$  and  $Q(x_2, y_2)$  be two points on a line making an angle  $\theta$  with the positive direction of  $x$  – axis. Draw  $PM$ ,  $QN$  perpendiculars on  $x$  – axis and  $PL$  perpendicular on  $QN$ .

Then,  $PL = MN = ON - OM = x_2 - x_1$

and  $QL = ON - LN = QN - PM = y_2 - y_1$

In  $\triangle PQL$ ,  $\tan \theta = QL/PL = (y_2 - y_1)/(x_2 - x_1)$

Thus, if  $(x_1, y_1)$  and  $(x_2, y_2)$  are coordinates of any two points on a line, then its slope is

$m = (y_2 - y_1)/(x_2 - x_1)$

$m = \text{Difference of } \text{ordinates}$

$\text{Difference of } \text{abscissae}$

or,  $m = \frac{\text{Vertical Step}}{\text{Horizontal Step}}$

## Angle between two lines

The angle  $\theta$  between the lines having slopes  $m_1$  and  $m_2$  is given by

$$\tan \theta = \left| \frac{m_2 - m_1}{1 + m_1 m_2} \right|$$

## Slope (Gradient) of Parallel lines

If two lines of slopes  $m_1$  and  $m_2$  are parallel, then the angle  $\theta$  between them is  $0^\circ$ .

$$\tan \theta = \tan 0^\circ = 0$$

$$m_2 - m_1 = 0$$

$$1 + m_1 m_2$$

$$m_2 = m_1$$

Thus, when two lines are parallel, their slopes are equal.

## Slope (Gradient) of Perpendicular lines

If two lines of slope  $m_1$  and  $m_2$  are perpendicular, then the angle  $\theta$  between them is of  $90^\circ$

$$\cot \theta = \frac{m_2 - m_1}{1 + m_1 m_2}$$

$$0 = \frac{m_2 - m_1}{1 + m_1 m_2}$$

$$0 = 1 + m_1 m_2$$

$$m_1 m_2 = -1$$

Thus, when two lines are perpendicular, the product of their slopes is -1. If  $m$  is the slope of a line, then the slope of a line perpendicular to it is  $-(1/m)$ .

Now try it yourself! Should you still need any help, [click here](#) to schedule live online session with e Tutor!

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## Reference Links :

- <http://en.wikipedia.org/wiki/Slope>
- <http://en.wikipedia.org/wiki/Perpendicular>
- <http://www.thefreedictionary.com/ordinates>

- <http://en.wikipedia.org/wiki/Abscissa>

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