

Equation of a Line

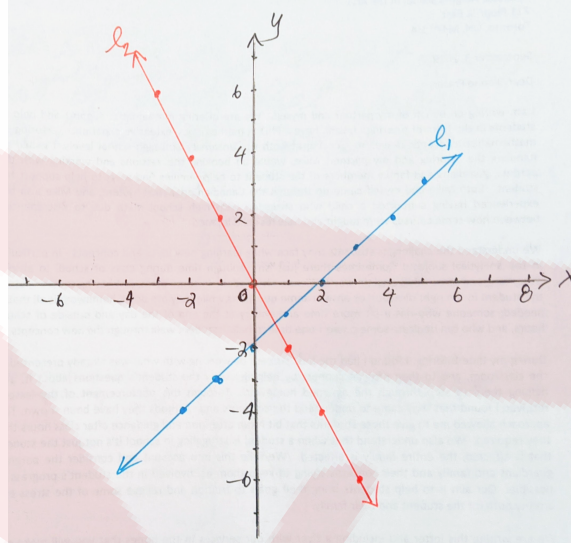
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## Equation of a Line

A line can be thought of as the extension of a set of points that when joined create a straight line segment.



We have two lines  $l_1$  and  $l_2$ . What are the slopes of  $l_1$  and  $l_2$ , respectively? We need to find two points on  $l_1$  and then calculate the *rise* and *run*. Two points on  $l_1$ :  $(x_0, y_0) = (1, -1)$  and  $(x_1, y_1) = (4, 2)$ .

$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{y_1 - y_0}{x_1 - x_0} = \frac{2 - (-1)}{4 - 1} = \frac{3}{3} = 1$$

Therefore, the slope of line  $l_1$  is 1. We usually represent the slope by  $m$ . So let's let the slope of  $l_1$  be  $m_1 = 1$ .

Calculate slope of  $l_2$ . Two points on  $l_2$ :  $(x_0, y_0) = (-1, 2)$  and  $(x_1, y_1) = (2, -4)$ .

$$\text{slope of } l_2 = m_2 = \frac{y_1 - y_0}{x_1 - x_0} = \frac{-4 - 2}{2 - (-1)} = \frac{-6}{3} = -2$$

Therefore, the slope of line  $l_2$  is  $m_2 = -2$ .

The *equation of a line* in general is given by,

$$y = mx + b$$

where  $m$  is the slope of the line and  $b$  is the y-intercept of the line.

### 0.1 What is the y-intercept?

The y-intercept is the point where the line crosses the y-axis. It can also be calculated by substituting  $x = 0$  into the equation of a line. We can also find the y-intercept by plugging the coordinates of a point on the line into the equation for the line.

Let's try and find the y-intercept of  $l_1$ . We have the slope for  $l_1$  as  $m_1 = 1$ . The equation of line  $l_1$  so far is,

$$y = m_1x + b_1 = x + b_1$$

where  $b_1$  is the y-intercept of  $l_1$ . Let's take a point on  $l_1$   $(1, -1)$  and plug it into  $l_1$ .

$$\begin{aligned} y &= x + b_1 \\ -1 &= 1 + b_1 \\ -2 &= b_1 \end{aligned}$$

Now we have the y-intercept and the equation of the line  $l_1$  is

$$\begin{aligned} l_1 : y &= m_1x + b_1 \\ y &= x - 2 \end{aligned}$$

Let's find the complete equation for the line  $l_2$ . We already have that the slope is  $m_2 = -2$ . One point on line  $l_2$  is  $(x_0, y_0) = (-1, 2)$ . Let's use this point to find the y-intercept.

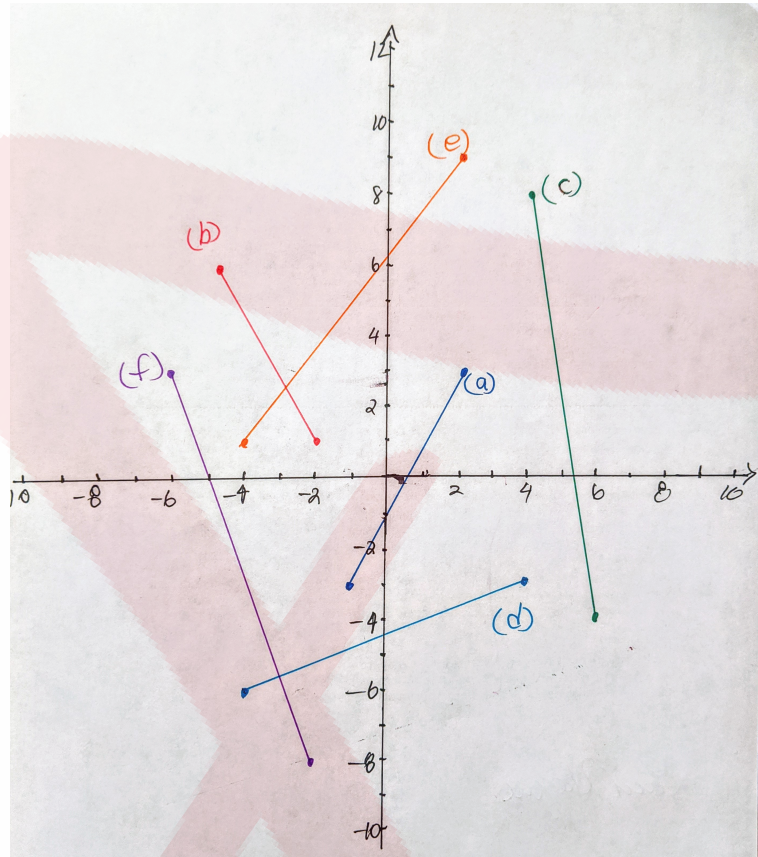
$$\begin{aligned} y &= -2x + b_2 \\ 2 &= -2(-1) + b_2 \\ \therefore 0 &= b_2 \end{aligned}$$

Now we have the equation for line  $l_2$  as,

$$\begin{aligned} l_2 : y &= m_2x + b_2 \\ y &= -2x + 0 \\ y &= -2x \end{aligned}$$

## Exercises

1. Find the slope of each line segment.



2. Find the y-intercept for each line extrapolated from the line segments above.
3. Write the equation for each line above.