

Linear Equation in Two Variables

An equation of the form $ax + by + c = 0$ (a, b, c are real numbers and a and b are not both zero) is called a linear equation in two variables.

General Form

$$ax + by + c = 0$$

- a, b and c are real numbers.
- a and b are not both zero (at least one of them is non-zero).
- x and y are variables.

Each Point Satisfies the Equation

A linear equation in two variables has **infinitely many solutions**. Each solution is an ordered pair (x, y) that satisfies the equation.



So, the graph of a linear equation in two variables is a straight line.

Examples

- 1 $2x + 3y + 5 = 0$
- 2 $x - y = 4$ (or $x - y - 4 = 0$)
- 3 $3x + 2y = 6$ (or $3x + 2y - 6 = 0$)
- 4 $5x - 7y + 1 = 0$

Example: Check a Solution

Is $(2, 1)$ a solution of $3x - 2y = 4$?

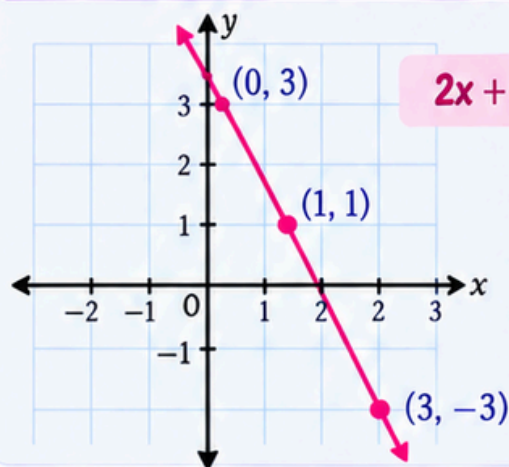
Substitute $x = 2, y = 1$:

$$3(2) - 2(1) = 6 - 2 = 4$$

Yes, $(2, 1)$ is a solution.



Graph of a Linear Equation



$$2x + y = 3$$

All the points on this line satisfy the equation $2x + y = 3$.

Key Points

- ✓ It represents a straight line in the Cartesian plane.
- ✓ It has infinitely many solutions.
- ✓ The solutions are ordered pairs (x, y) .
- ✓ If we plot all the solutions, we get a straight line.
- ✓ Examples: $x + y = 5$, $3x - 2y = 4$, etc.

**One Equation
Infinite Possibilities!**

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Pair of Linear Equations

A pair of linear equations in two variables consists of two linear equations, each of the form $ax + by + c = 0$, where a, b, c are real numbers and a and b are not both zero.

General Form

$$a_1x + b_1y + c_1 = 0$$

$$a_2x + b_2y + c_2 = 0$$

where $a_1, b_1, c_1, a_2, b_2, c_2$ are real numbers and a_1, b_1 are not both zero, a_2, b_2 are not both zero.

Examples of Pairs of Linear Equations

1

$$2x + 3y = 5$$

$$4x - y = 1$$

2

$$x + y = 6$$

$$3x - 2y = 4$$

3

$$5x - 7y + 1 = 0$$

$$2x + 3y - 6 = 0$$

4

$$x - 4y = 8$$

$$3x + 2y = 10$$

Each equation is linear in the variables x and y .

Solution of a Pair of Linear Equations

A solution of a pair of linear equations is an ordered pair (x, y) that satisfies both equations simultaneously.

We need to find the value(s) of x and y that make both equations true.

Example: Check a Solution

Is $(1, 2)$ a solution of the pair?

$$x + 2y = 5 \quad \text{and} \quad 3x - y = 1$$

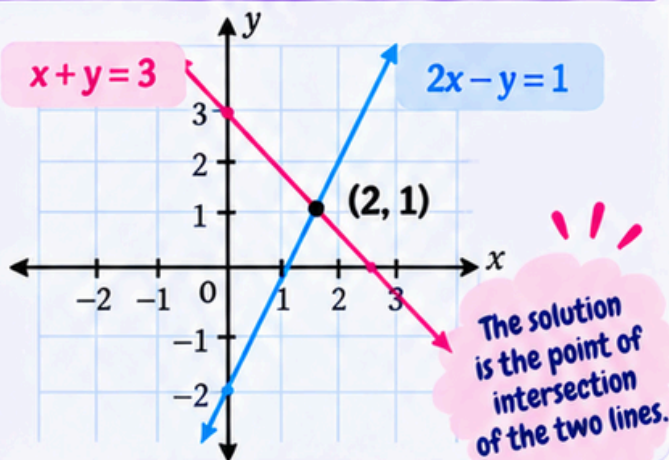
Substitute $x = 1, y = 2$:

$$1 + 2(2) = 1 + 4 = 5 \quad \checkmark$$

$$3(1) - 2 = 3 - 2 = 1 \quad \checkmark$$

Yes, $(1, 2)$ is a solution.

Graphical Representation



Key Points

- ✓ A pair consists of two linear equations in the same two variables.
- ✓ Each equation is of the form $ax + by + c = 0$.
- ✓ A solution is an ordered pair (x, y) that satisfies both equations.
- ✓ A pair can have a unique solution, infinitely many solutions or no solution (discussed next).
- ✓ It can be solved by algebraic methods or graphical method.

Two Equations
One Solution (or more!)

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Slope = Rise/Run

The slope of a line tells us how much the y -value changes for a given change in the x -value. It is the ratio of the **vertical change (rise)** to the **horizontal change (run)**.

Formula

$$m = \frac{\text{Rise}}{\text{Run}} = \frac{\Delta y}{\Delta x}$$

If a line passes through two points (x_1, y_1) and (x_2, y_2) , then

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

What do Rise and Run Mean?

- Rise (Δy):** Vertical change (up or down) in the y -direction.
- Run (Δx):** Horizontal change (left or right) in the x -direction.
- Slope (m):** Ratio of rise to run.

Same idea,
new
possibilities!

Slope tells us the steepness and direction of a line.

Example: Find the Slope

Find the slope of the line passing through $A(2, 0)$ and $B(4, 3)$.



Solution:

$$m = \frac{\text{Rise}}{\text{Run}} = \frac{3}{2}$$

$$m = \frac{3}{2}$$

The slope is $\frac{3}{2}$.

The line rises 3 units for every 2 units to the right.

Types of Slopes

Type	Slope (m)	Graph
Positive slope	$m > 0$	Line rises from left to right.
Negative slope	$m < 0$	Line falls from left to right.
Zero slope	$m = 0$	Horizontal line ($y = \text{constant}$).
Undefined slope	Not defined	Vertical line ($x = \text{constant}$).

Key Points

- ✓ Slope is the ratio of vertical change to horizontal change.
- ✓ It can be positive, negative, zero or undefined.
- ✓ A larger absolute value of slope means a steeper line.
- ✓ Horizontal lines have zero slope.
- ✓ Vertical lines have undefined slope.
- ✓ Slope helps us compare and graph linear equations.

Small Changes
Make a Big Difference!

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Slope Formula

The **slope** of a line passing through two points (x_1, y_1) and (x_2, y_2) is given by:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

Same formula,
many
possibilities!

What the Symbols Mean?

- (x_1, y_1) and (x_2, y_2) are two distinct points on the line.
- $y_2 - y_1$ is the vertical change (**rise**).
- $x_2 - x_1$ is the horizontal change (**run**).
- m is the slope of the line.

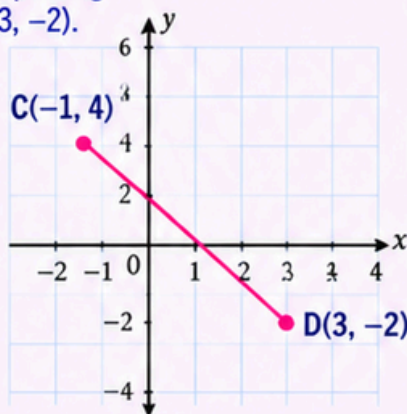
Example 2: Find the Slope

Find the slope of the line passing through $C(-1, 4)$ and $D(3, -2)$.

Solution:

$$\begin{aligned} m &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{-2 - 4}{3 - (-1)} \\ &= \frac{-6}{4} \\ &= -\frac{3}{2} \end{aligned}$$

Slope = $-\frac{3}{2}$



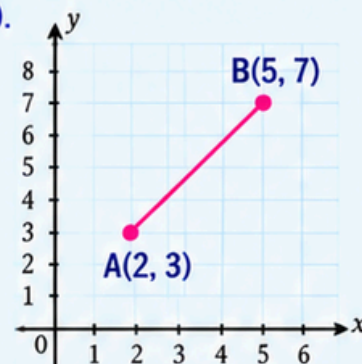
Example 1: Find the Slope

Find the slope of the line passing through $A(2, 3)$ and $B(5, 7)$.

Solution:

$$\begin{aligned} m &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{7 - 3}{5 - 2} \\ &= \frac{4}{3} \end{aligned}$$

Slope = $\frac{4}{3}$



Example 3: Slope from a Table of Points

Find the slope of the line passing through $(0, 2)$ and $(4, 6)$.

Solution:

$$m = \frac{6 - 2}{4 - 0} = \frac{4}{4} = 1$$

Slope = 1

x	y
0	2
4	6

Special Cases

Case	Points	Slope (m)
Positive slope	$y_2 > y_1$ (as $x_2 > x_1$)	$m > 0$
Negative slope	$y_2 < y_1$ (as $x_2 > x_1$)	$m < 0$
Zero slope	$y_2 = y_1$	$m = 0$
Undefined slope	$x_2 = x_1$ (vertical line)	Not defined

Key Points

- ✓ The slope formula works for any two distinct points on a line.
- ✓ It gives the same slope no matter which two points we choose.
- ✓ Positive slope means the line rises from left to right.
- ✓ Negative slope means the line falls from left to right.
- ✓ Horizontal line has slope 0.
- ✓ Vertical line has an undefined slope.

**Find the slope,
find the direction!**

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**Maths is
a journey of
discovery!**





Slope-Intercept Form

The slope-intercept form of a linear equation in two variables is

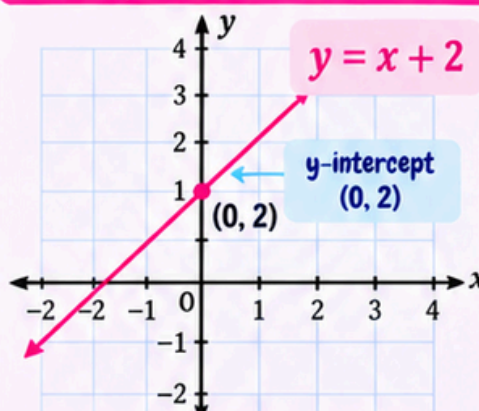
$$y = mx + d$$

where m is the slope of the line and d is the y-intercept (the point where the line crosses the y-axis).

What the Terms Mean?

- **m : Slope of the line**
 - $m > 0 \rightarrow$ line rises from left to right
 - $m < 0 \rightarrow$ line falls from left to right
 - $m = 0 \rightarrow$ horizontal line
 - m is undefined $\rightarrow$ vertical line
- **d : y-intercept**
 - It is the value of y when $x = 0$.
 - The line passes through the point $(0, d)$.

Graph of $y = mx + d$



Here, $m = 1$ and $d = 2$.

Key Features

- ✓ The equation is in the form $y = mx + d$.
- ✓ m gives the slope (steepness and direction) of the line.
- ✓ d is the y-intercept.
- ✓ The line always passes through $(0, d)$.
- ✓ This form is convenient for graphing a line.

Example 1: Identify m and d

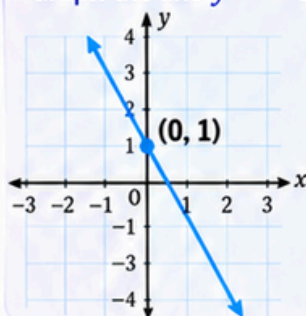
Find the slope and y-intercept of $y = 3x - 4$.

Here, $m = 3$
and $d = -4$.

Slope = 3
Y-intercept = -4
 $(0, -4)$

Example 2: Graph the Equation

Graph the line $y = -2x + 1$.



Here,
 $m = -2$
and $d = 1$.
The line
passes through
 $(0, 1)$.

Example 3: Find the Equation

A line has slope 4 and y-intercept -3 .
Write its equation in slope-intercept form.

Use $y = mx + d$
Substitute $m = 4$ and $d = -3$.

$$y = 4x - 3$$

Special Cases

Equation	Slope (m)	y-intercept (d)	Type of Line
$y = 2x + 5$	2	5	Rises
$y = -3x + 1$	-3	1	Falls
$y = 0x + 4$	0	4	Horizontal
$x = 2$ (cannot be written in this form)	Undefined	-	Vertical



The y-intercept
tells us where the
line crosses the
y-axis!

Key Takeaways

- ✓ Slope-intercept form: $y = mx + d$
- ✓ m is the slope and d is the y-intercept.
- ✓ The line passes through $(0, d)$.
- ✓ Helps us quickly graph and compare lines.
- ✓ Works for all non-vertical lines.

Same Equation.
Different Lines. Infinite Possibilities!

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Slope from Standard Form

A linear equation in two variables can be written in standard form as

$$ax + by + c = 0$$

where a, b, c are real numbers and a and b are not both zero.

Derivation

From $ax + by + c = 0$

$$by = -ax - c$$

$$y = -\frac{a}{b}x - \frac{c}{b} \quad (b \neq 0)$$

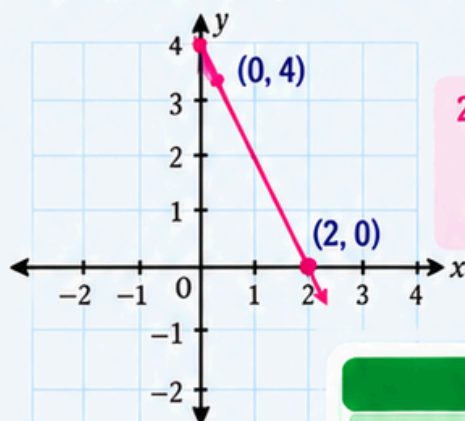
This is in the form $y = mx + d$

So, the slope of the line is $m = -\frac{a}{b}$

and the y-intercept is $d = -\frac{c}{b}$

Graphical Example

Graph the line $2x - y + 4 = 0$ and find its slope.



$$\begin{aligned} 2x - y + 4 &= 0 \\ y &= 2x + 4 \\ \text{Slope (m)} &= 2 \end{aligned}$$

Example 1: Find the Slope

Find the slope of $3x + 2y - 6 = 0$.

Solution:

Here, $a = 3$, $b = 2$, $c = -6$

$$\text{Slope, } m = -\frac{a}{b} = -\frac{3}{2}$$

$$\text{Slope} = -\frac{3}{2}$$

Example 2: Find the Slope

Find the slope of $5x - 4y + 8 = 0$.

Solution:

Here, $a = 5$, $b = -4$, $c = 8$

$$\text{Slope, } m = -\frac{a}{b} = -\frac{5}{-4} = \frac{5}{4}$$

$$\text{Slope} = \frac{5}{4}$$

Example 3: Find the Equation from a Given Slope

A line has slope -2 and y-intercept 3 . Write its equation in standard form.

Solution:

Given $m = -2$ and $d = 3$.

Equation in slope-intercept form: $y = -2x + 3$

Convert to standard form: $2x + y - 3 = 0$

$$\begin{aligned} \text{Standard form:} \\ 2x + y - 3 &= 0 \end{aligned}$$

Quick Reference Table

Equation (Standard Form)	Slope (m)	y-intercept (d)
$x + y - 2 = 0$	-1	2
$2x - 3y + 6 = 0$	$\frac{2}{3}$	2
$3x + 6y - 9 = 0$	$-\frac{1}{2}$	$\frac{3}{2}$

Key Points

- ✓ From $ax + by + c = 0$, slope $m = -\frac{a}{b}$ ($b \neq 0$).
- ✓ y-intercept is $d = -\frac{c}{b}$.
- ✓ Convert to slope-intercept form to easily graph the line.
- ✓ The slope tells the direction and steepness of the line.
- ✓ Works for any linear equation in two variables.

**From Standard Form
to Slope — It's Easy!**

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**Same Equation.
Different Points.
Same Slope!**



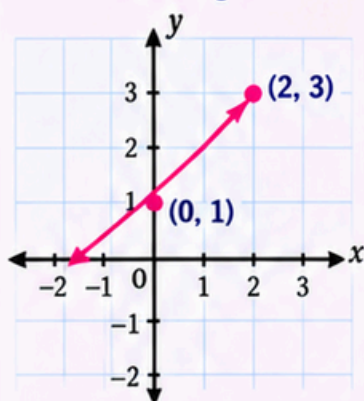
Positive/Negative/Zero/Undefined Slope

The slope of a line tells us its steepness and direction.
It can be **positive**, **negative**, **zero** or **undefined**.

Positive Slope

$$m > 0$$

The line rises from left to right.



Example:

Line passing through (0, 1) and (2, 3)

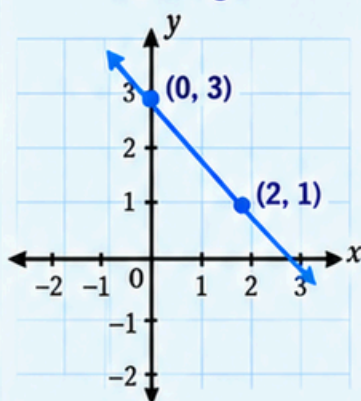
$$m = \frac{3 - 1}{2 - 0} = \frac{2}{2} = 1$$

Slope = 1

Negative Slope

$$m < 0$$

The line falls from left to right.



Example:

Line passing through (0, 3) and (2, 1)

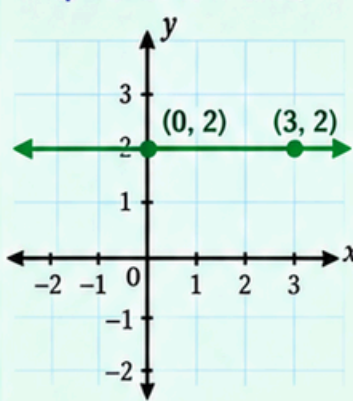
$$m = \frac{1 - 3}{2 - 0} = \frac{-2}{2} = -1$$

Slope = -1

Zero Slope

$$m = 0$$

The line is horizontal (parallel to x-axis).



Example:

Line through (0, 2) and (3, 2)

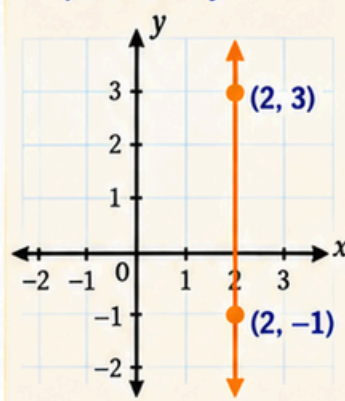
$$m = \frac{2 - 2}{3 - 0} = \frac{0}{3} = 0$$

Slope = 0

Undefined Slope

Undefined

The line is vertical (parallel to y-axis).



Example:

Vertical line through (2, 3) and (2, -1)

$$m = \frac{-1 - 3}{2 - 2} = \frac{-4}{0}$$

(division by zero)

Slope = Undefined

Summary

Slope (m)	Line	Graph
$m > 0$	Rises from left to right	
$m < 0$	Falls from left to right	
$m = 0$	Horizontal line ($y = \text{constant}$)	
Undefined	Vertical line ($x = \text{constant}$)	

Key Points

- ✓ Slope tells us the steepness and direction of a line.
- ✓ $m > 0 \rightarrow$ line rises from left to right.
- ✓ $m < 0 \rightarrow$ line falls from left to right.
- ✓ $m = 0 \rightarrow$ horizontal line.
- ✓ Slope is undefined $\rightarrow$ vertical line.
- ✓ Vertical lines do not have a slope (denominator becomes zero).

**Different Slopes
Different Directions!
Same Straight Line Family!**

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Three Cases of Solutions

A pair of linear equations in two variables can have **three possible cases of solutions** depending on the relationship between their coefficients.

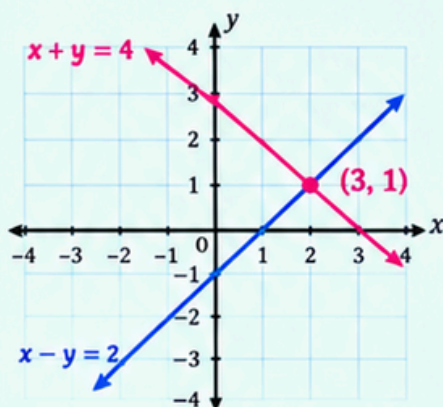
Case 1: Unique Solution (Intersecting Lines)

$$\text{If } \frac{a_1}{a_2} \neq \frac{b_1}{b_2}$$

The two lines intersect at exactly one point.

Example:

$$x + y = 4 \quad \text{and} \quad x - y = 2$$



The pair has a unique solution
 $x = 3, y = 1$.

Case 2: Infinitely Many Solutions (Coincident Lines)

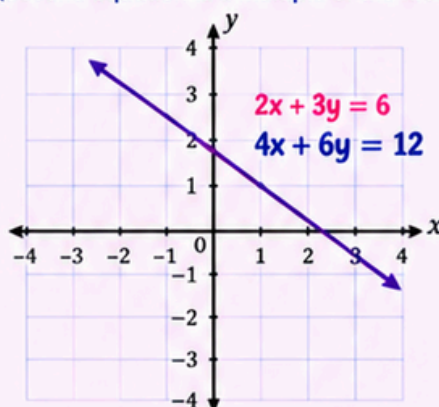
$$\text{If } \frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

The two lines represent the same line (coincident lines).

Example:

$$2x + 3y = 6 \quad \text{and} \quad 4x + 6y = 12$$

(Second equation is a multiple of the first)



The pair has infinitely many solutions.

Case 3: No Solution (Parallel Lines)

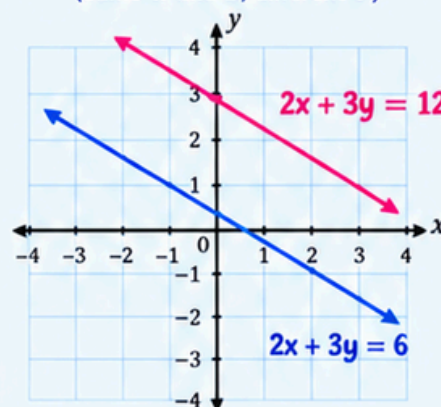
$$\text{If } \frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$$

The two lines are parallel and never intersect.

Example:

$$2x + 3y = 6 \quad \text{and} \quad 2x + 3y = 12$$

(Same a and b , different c)



The pair has no solution.

Summary Table

Case	Condition	Graph	Number of Solutions	Lines are
Unique solution	$\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$	Intersecting lines	One solution	Meet at one point
Infinitely many solutions	$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$	Coincident lines	Infinitely many	Same line
No solution	$\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$	Parallel lines	No solution	Parallel (never meet)

Key Points

- ✓ A pair of linear equations can have one, infinitely many or no solution.
- ✓ It depends on the relationship between their coefficients.
- ✓ Intersecting lines → unique solution.
- ✓ Coincident lines → infinitely many solutions.
- ✓ Parallel lines → no solution.
- ✓ Graph helps us visualize the solution.
- ✓ Used to solve real-life problems.

**Different Equations
Different Possibilities
Same Mathematics!**

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Builds Brighter
Futures!**



Graph of a Linear Equation

The graph of a linear equation in two variables is a **straight line**.
Every point on the line represents a **solution** (an ordered pair) of the equation.

Example: Graph the Equation

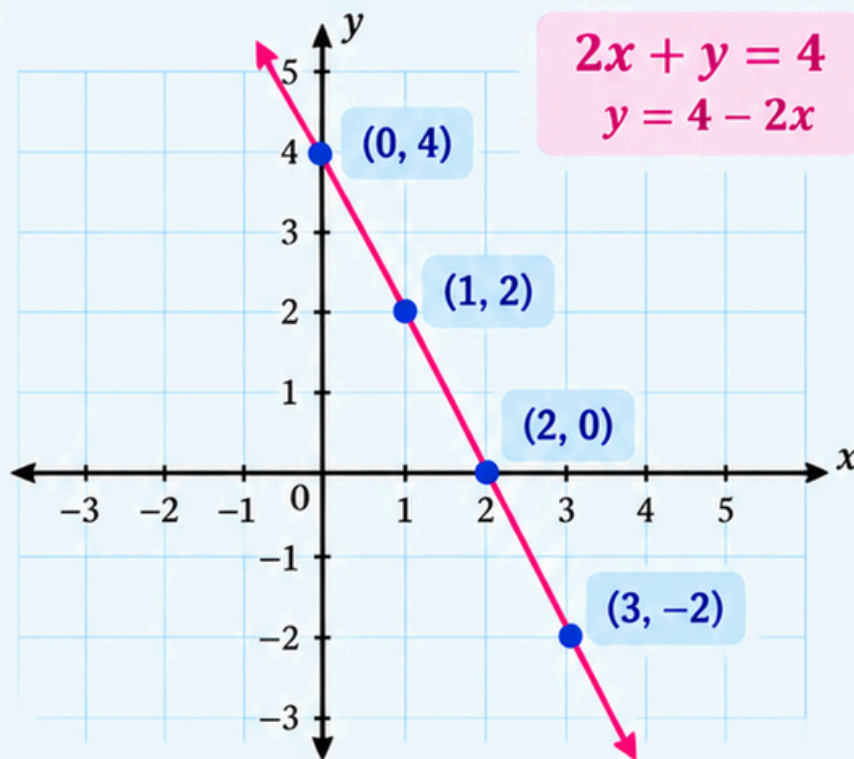
$$2x + y = 4$$

- Step 1:** Make a table of values.
- Step 2:** Plot the ordered pairs on the coordinate plane.
- Step 3:** Join the points to get a straight line.

Table of Values

x	$y = 4 - 2x$	Ordered Pair (x, y)
0	4	(0, 4)
1	2	(1, 2)
2	0	(2, 0)
3	-2	(3, -2)

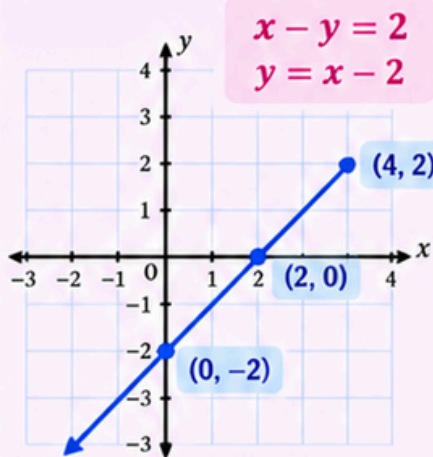
Graph of $2x + y = 4$



Another Example

Graph the equation $x - y = 2$.

x	$y = x - 2$	(x, y)
0	-2	(0, -2)
2	0	(2, 0)
4	2	(4, 2)



Key Points

- ✓ The graph of a linear equation is a straight line.
- ✓ Every point on the line is a solution of the equation.
- ✓ To graph, make a table of values, plot the points and join them.
- ✓ The line extends infinitely in both directions.
- ✓ A linear equation has infinitely many solutions.

**Plot the points,
join the line and
find all the solutions!**

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**A Straight Line
Many Solutions
Infinite Possibilities!**





Rise and Run Diagram

Slope shows how steep a line is. We can find the slope using the **rise** and **run**.

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}}$$

What do they mean?

- **Rise:** The vertical change (move up or down).
- **Run:** The horizontal change (move right or left).

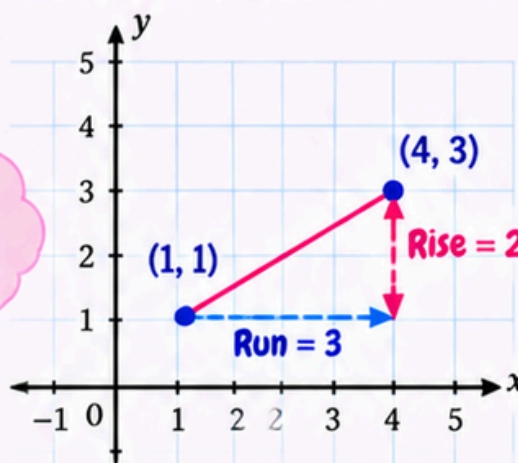
Always move from the left point to the right point on the graph.

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}}$$



Example 1: Positive Slope

Find the slope using rise and run.



$$\text{Slope} = \frac{\text{Rise}}{\text{Run}}$$

$$\text{Rise} = 3 - 1 = 2$$

$$\text{Run} = 4 - 1 = 3$$

$$\text{Slope} = \frac{2}{3}$$

$$m = \frac{2}{3}$$

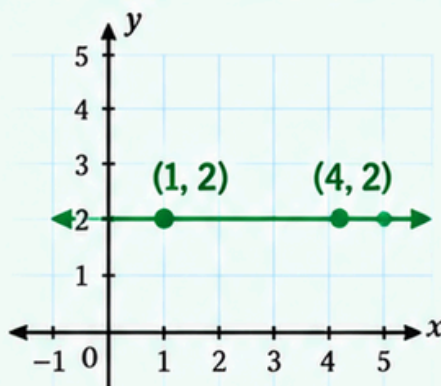
Example 2: Negative Slope



$$\text{Slope} = \frac{-3}{3} = -1$$

$$m = -1$$

Example 3: Zero Slope

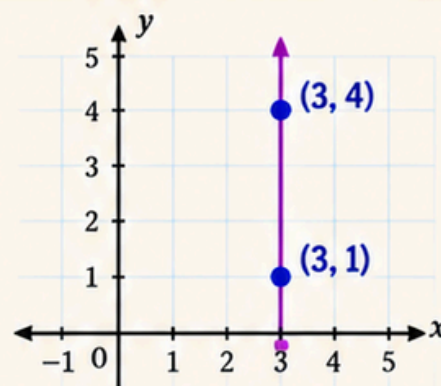


$$\text{Rise} = 0, \text{Run} = 3$$

$$\text{Slope} = \frac{0}{3} = 0$$

$$m = 0$$

Example 4: Undefined Slope



$$\text{Run} = 0 \text{ (vertical line)}$$

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

$$m = \text{undefined}$$

Same Idea.
Different Lines.
Find the Slope!

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Small Steps
Big Progress!

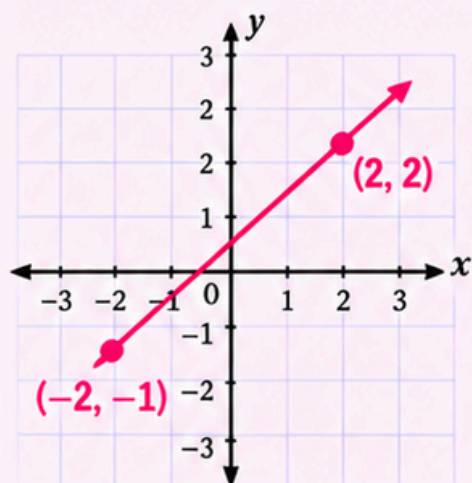


Positive vs Negative Slope

The slope of a line tells us its direction. It can be **positive** or **negative**.
Both show a straight line, but they slope in opposite directions.

Positive Slope ($m > 0$)

The line **rises** from left to right.



Example:

$$y = x$$

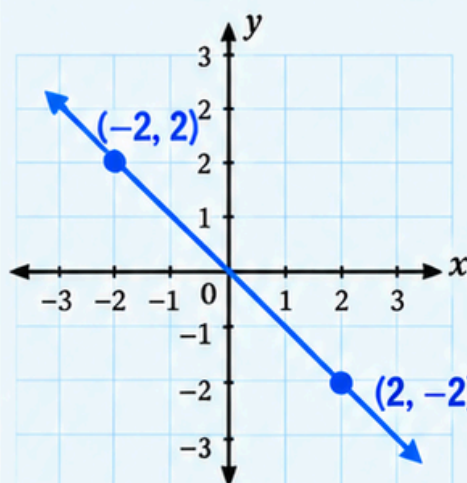
Slope, $m = 1$
(positive)

$$m > 0$$

As x increases, y also increases.

Negative Slope ($m < 0$)

The line **falls** from left to right.



Example:

$$y = -x$$

Slope, $m = -1$
(negative)

$$m < 0$$

As x increases, y decreases.

Key Points

- ✓ Positive slope ($m > 0$) → line rises from left to right.
- ✓ Negative slope ($m < 0$) → line falls from left to right.
- ✓ The sign of the slope tells the direction of the line.
- ✓ A steeper line has a larger absolute value of slope.
- ✓ Both positive and negative slopes represent straight lines.

More Examples

Positive Slopes

$$y = 2x + 1 \quad (m = 2)$$

$$y = \frac{1}{2}x - 3 \quad (m = \frac{1}{2})$$

$$y = 3x \quad (m = 3)$$

$$m > 0$$

Negative Slopes

$$y = -2x + 4 \quad (m = -2)$$

$$y = -\frac{1}{3}x + 1 \quad (m = -\frac{1}{3})$$

$$y = -5x \quad (m = -5)$$

$$m < 0$$

**Different Directions
Same Straight Lines!**

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**Understand
Slopes,
Build Confidence!**



Horizontal Line — Zero Slope

A horizontal line is a line that is **parallel to the x-axis**. It has **zero slope ($m = 0$)** because there is no vertical change ($\text{rise} = 0$) as we move from left to right.

Equation of a Horizontal Line

A horizontal line has equation of the form

$$y = k$$

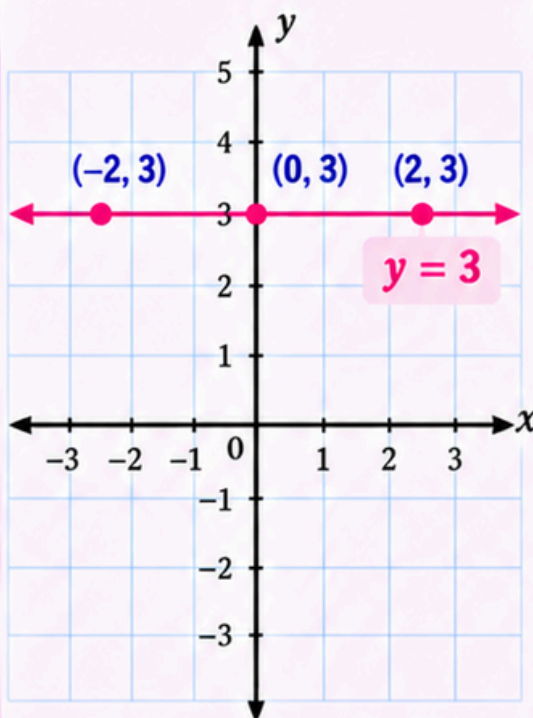
where k is a constant.

Examples:

- $y = 3$
- $y = -2$
- $y = 0$ (x-axis)
- $y = 5$

All these are horizontal lines and have slope 0.

Graph of $y = 3$



Key Points

- ✓ A horizontal line is parallel to the x-axis.
- ✓ It has zero slope ($m = 0$).
- ✓ The y-coordinate is the same for every point on the line.
- ✓ There is no vertical change ($\text{rise} = 0$).
- ✓ The line extends infinitely in both directions.
- ✓ Equation of a horizontal line: $y = k$ (k is a constant).

Slope Calculation

Take any two points on the line $y = 3$, for example $(-2, 3)$ and $(2, 3)$.

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{3 - 3}{2 - (-2)} = \frac{0}{4} = 0$$

$$\text{Slope} = 0$$

More Examples

Equation	Graph	Slope
$y = 4$		$m = 0$
$y = -1$		$m = 0$
$y = 0$ (x-axis)		$m = 0$
$y = -5$		$m = 0$

**Different Lines.
Different Slopes.
Stronger Maths!**

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**Same Idea.
New Possibilities!**



Vertical Line – Undefined Slope

A vertical line is a line that is **parallel to the y-axis**. Its slope is **undefined** because there is no horizontal change ($\text{run} = 0$) as we move from one point to another.

Equation of a Vertical Line

A vertical line has equation of the form

$$x = h$$

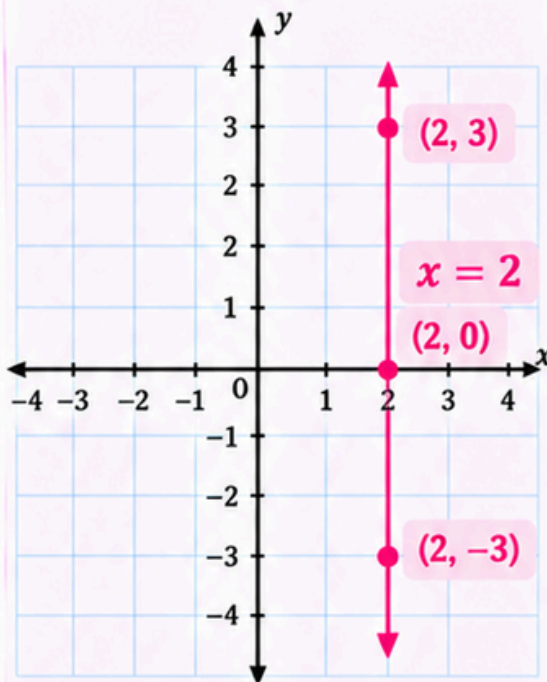
where h is a constant.

Examples:

- $x = 2$
- $x = -3$
- $x = 0$ (y-axis)
- $x = 5$

All these are vertical lines and have undefined slope.

Graph of $x = 2$



Key Points

- ✓ A vertical line is parallel to the y-axis.
- ✓ Its equation is $x = h$ (h is a constant).
- ✓ It has **undefined** slope (since $\text{run} = 0$).
- ✓ The x -coordinate is the same for every point on the line.
- ✓ There is no horizontal change ($\text{run} = 0$).
- ✓ The line extends infinitely in both directions.

Why is the slope undefined?

Slope is given by $m = \frac{y_2 - y_1}{x_2 - x_1}$.

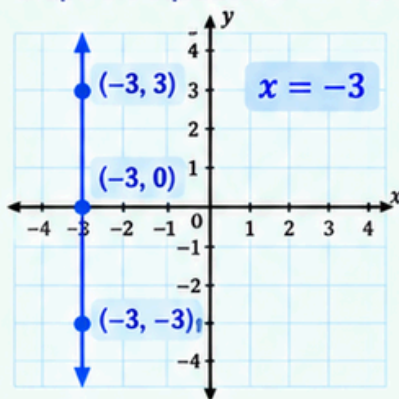
For a vertical line, $x_2 - x_1 = 0$ ($\text{run} = 0$).

Division by zero is not defined.
So, the slope is undefined.

Slope = undefined

Another Example

Graph the equation $x = -3$.



Summary Table

Line	Equation	Slope	Graph
Vertical line	$x = h$	Undefined	
Horizontal line	$y = k$	0	

**Different Lines.
Different Slopes.
Same Possibilities!**

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**Maths
Builds Brighter
Futures!**



Slope-Intercept Diagram

The slope-intercept form of a linear equation is $y = mx + c$.
Here, m is the slope and c is the **y-intercept** (the point where the line cuts the y-axis).

1. The Form

$$y = mx + c$$

m → slope (rate of change)

c → y-intercept
(y-coordinate where $x = 0$)

The graph is a straight line with slope m and it crosses the y-axis at $(0, c)$.

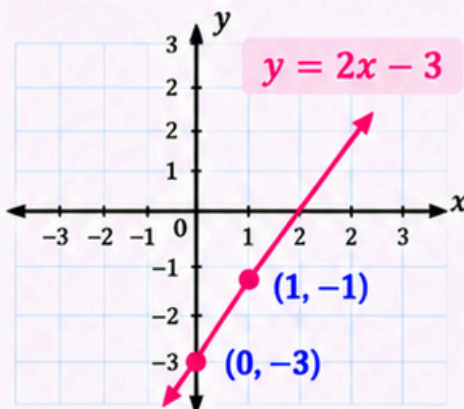
2. Identify m and c

In the equation $y = 2x - 3$,

$$m = 2$$

$$c = -3$$

So, the line has slope 2 and y-intercept $(0, -3)$.



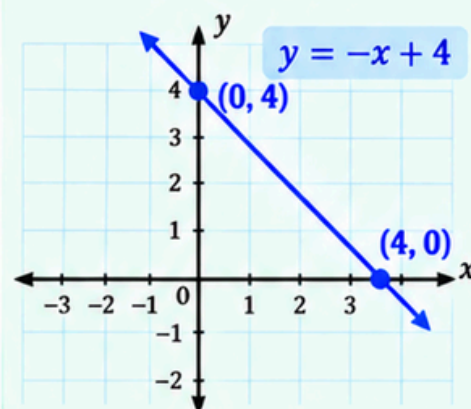
3. Another Example

In the equation $y = -x + 4$,

$$m = -1$$

$$c = 4$$

So, the line has slope -1 and y-intercept $(0, 4)$.



More Examples

Equation	Slope (m)	y-intercept (c)	Graph
$y = x + 2$	1	2	
$y = -2x + 1$	-2	1	
$y = 3x$	3	0	
$y = \frac{1}{2}x - 3$	$\frac{1}{2}$	-3	

Key Points

- ✓ Slope-intercept form: $y = mx + c$
- ✓ m is the slope.
- ✓ c is the y-intercept $(0, c)$.
- ✓ If $m > 0$, the line rises from left to right.
- ✓ If $m < 0$, the line falls from left to right.
- ✓ If $m = 0$, the line is horizontal ($y = c$).
- ✓ The graph is always a straight line.

Real Life Tip



The slope tells us how much y changes when x increases by 1 unit.

A positive slope means y increases.

A negative slope means y decreases.

**Same Equation Symbol.
Different Lines.
Infinite Possibilities!**

**★ Understand the form.
plot the points.
see the line!**

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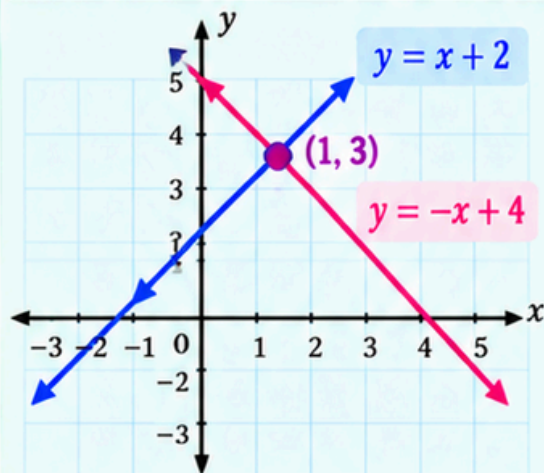


**Maths
Today
A Brighter
Tomorrow!**

Intersecting Lines

Two lines are called **intersecting lines** if they meet at exactly one point.
The point where they meet is called the **point of intersection**.

Graph of Intersecting Lines



The lines $y = x + 2$ and $y = -x + 4$ intersect at the point $(1, 3)$.

Find the Point of Intersection

Solve the two equations together.

$$y = x + 2 \quad \dots(1)$$

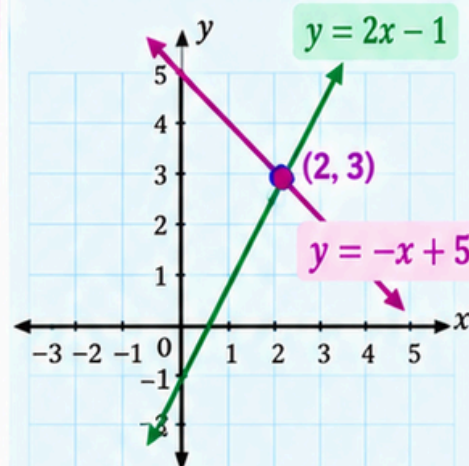
$$y = -x + 4 \quad \dots(2)$$

$$\begin{aligned} \text{From (1): } x + 2 &= -x + 4 \\ 2x &= 2 \\ x &= 1 \end{aligned}$$

$$\begin{aligned} \text{Substitute } x = 1 \text{ in (1):} \\ y &= 1 + 2 \\ y &= 3 \end{aligned}$$

Point of intersection = $(1, 3)$

Another Example



The lines $y = 2x - 1$ and $y = -x + 5$ intersect at $(2, 3)$.

Key Points

- ✓ Intersecting lines meet at exactly **one point**.
- ✓ The point where they meet is the **point of intersection**.
- ✓ The intersecting lines have **different slopes** ($m_1 \neq m_2$).
- ✓ They represent a system of linear equations with a **unique solution**.
- ✓ The graph shows the solution as a **single point**.

Compare with Other Cases



Intersecting lines

- Meet at one point
- Different slopes
- Unique solution



Parallel lines

- Never meet
- Same slope
- No solution



Coincident lines

- Same line (infinite points)
- Same slope and intercept
- Infinitely many solutions

Real Life Example



Two roads meeting at a crossing represent intersecting lines.

**Different Paths
Can Meet!
Maths is Everywhere!**

**Different Lines
Different Solutions
Stronger Mathematicians!**

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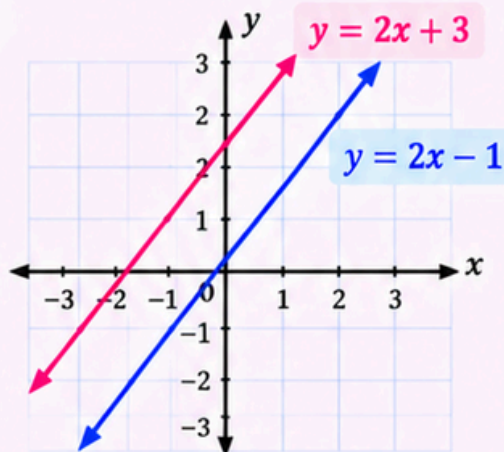


**Small
Steps
Big
Progress!**

Parallel Lines

Two lines are called **parallel lines** if they never meet, no matter how far they are extended.
Parallel lines have the **same slope** but **different y-intercepts**.

Graph of Parallel Lines



The lines $y = 2x + 3$ and $y = 2x - 1$ are parallel.
They have the **same slope (2)** but **different y-intercepts (3 and -1)**.

Equations of Parallel Lines

Two lines are parallel if their slopes are equal ($m_1 = m_2$) but their y-intercepts are different ($c_1 \neq c_2$).

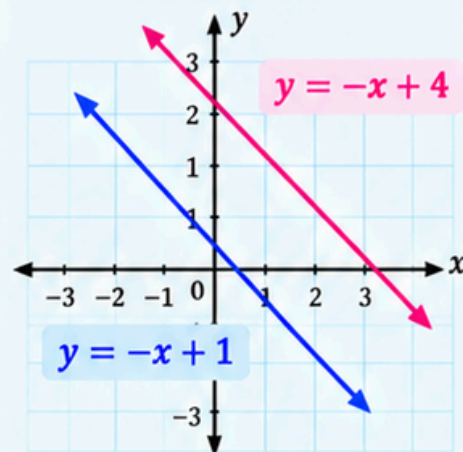
General form:
 $y = mx + c$

If two lines are parallel:

$$m_1 = m_2$$

$$c_1 \neq c_2$$

Another Example



The lines $y = -x + 4$ and $y = -x + 1$ are parallel.
They have the **same slope (-1)** but **different y-intercepts (4 and 1)**.

Key Points

- ✓ Parallel lines never meet.
- ✓ They have the same slope ($m_1 = m_2$).
- ✓ They have different y-intercepts ($c_1 \neq c_2$).
- ✓ They are always the same distance apart.
- ✓ In the form $y = mx + c$, parallel lines have the same value of m .

Compare with Other Cases

Case	Slope	Meet?	Example
Parallel lines	$m_1 = m_2$	Never meet	$y = 2x + 3$ and $y = 2x - 1$
Intersecting lines	$m_1 \neq m_2$	Meet at one point	$y = x + 2$ and $y = -x + 1$
Coincident lines	$m_1 = m_2$ and $c_1 = c_2$	Same line (infinite points)	$y = 2x + 3$ and $y = 2x + 3$

Real Life Example



The two railway tracks are parallel lines. They never meet and are always the same distance apart.

**Parallel Paths
Lead to a Bright Future!**

**Same Slope.
Different Intercepts.
Always Parallel!**

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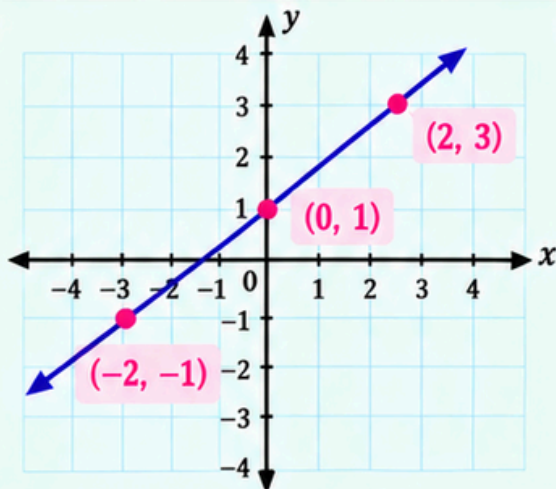


**Maths
Builds
Better
Opportunities!**

Coincident Lines

Two lines are called **coincident lines** if they represent the **same line**. They lie exactly on top of each other and have infinitely many common points.

Example: Coincident Lines



The lines $y = x + 1$ and $2y = 2x + 2$ are coincident. They represent the **same line** and lie on top of each other.

Equations of Coincident Lines

Two linear equations represent the same line if one equation is a non-zero multiple of the other.

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

Both equations represent the **same line**.

General form:

$$y = mx + c$$

If two lines are coincident:
 $m_1 = m_2$
 and
 $c_1 = c_2$

Check Using Coefficient

For two lines $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$, they are coincident if

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

Example:

$$x - y + 1 = 0 \quad \dots(1)$$

$$2x - 2y + 2 = 0 \quad \dots(2)$$

$$\text{Here, } \frac{1}{2} = \frac{-1}{-2} = \frac{1}{2}$$

So, the lines are **coincident**.

Key Points

- ✓ Coincident lines represent the **same line**.
- ✓ They lie exactly on top of each other.
- ✓ They have the same slope ($m_1 = m_2$) and the same y-intercept ($c_1 = c_2$).
- ✓ They have infinitely many common points.
- ✓ Geometrically, they look like a **single line**.

Comparing the Three Cases

Case	Slope (m)	y-intercept (c)	Graph	Common points
Intersecting lines	$m_1 \neq m_2$	$c_1 \neq c_2$		One point
Parallel lines	$m_1 = m_2$	$c_1 \neq c_2$		No point
Coincident lines	$m_1 = m_2$	$c_1 = c_2$		Infinitely many points

Real Life Example



The two yellow lines on the road represent coincident lines. They are the same line.

Same Line.
Different Equations.
Infinite Possibilities!

Same Line.
Same Solutions.
Stronger Mathematicians!

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Maths Today
A Brighter Tomorrow!

The **graphical method** is used to solve a pair of linear equations in two variables by drawing the graphs of the two equations. The coordinates of the **point of intersection** give the solution.

Steps of Graphical Method

- 1 Write the two linear equations.
- 2 Make a table of values for each equation (find at least two points).
- 3 Plot the points and draw the graphs of the two lines on the same coordinate plane.
- 4 Find the point of intersection of the two lines.
- 5 Read the coordinates of the point of intersection. These are the solution of the equations.

Example: Solve Graphically

$$x + y = 5$$

$$x - y = 1$$

Step 1: Make tables of values

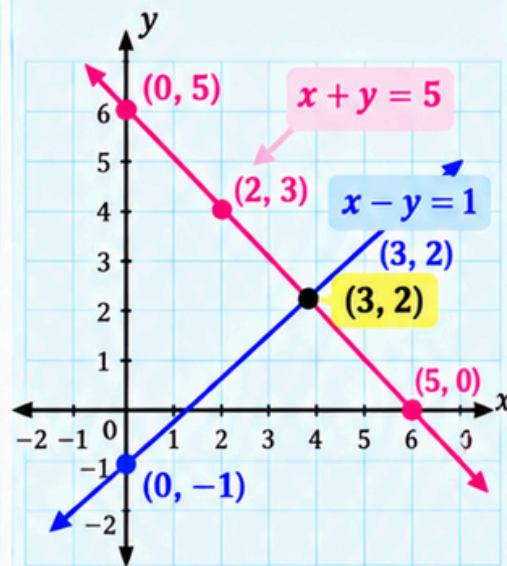
For $x + y = 5$

x	y
0	5
2	3
5	0

For $x - y = 1$

x	y
0	-1
1	0
3	2

Step 2: Plot the graphs



Step 3: Solution

The lines intersect at the point (3, 2).

So, the solution of the equations is

$$x = 3, \quad y = 2$$

Check the Solution

Substitute $x = 3, y = 2$ in both equations:

For $x + y = 5$:

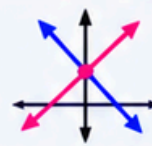
$$3 + 2 = 5 \quad \checkmark$$

For $x - y = 1$:

$$3 - 2 = 1 \quad \checkmark$$

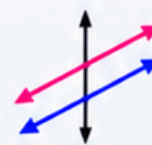
Hence, (3, 2) is the solution.

Special Cases



Intersecting lines

- One solution
- (the point of intersection)



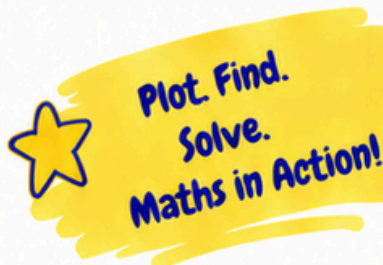
Parallel lines

- No solution
- (lines never meet)



Coincident lines

- Infinitely many solutions
- (both equations represent the same line)



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**Better
Graphs
Brighter
Futures!**