

Definition of slope of a line in math

**** Understand the slope of a line in math! This comprehensive guide defines slope, explains its calculation using different methods, and explores its applications. Learn about positive, negative, zero, and undefined slopes with examples. Master linear equations and graph interpretation. slope math geometry linealgebra linearequations**

Defining the Slope of a Line in Math: A Comprehensive Guide

The slope of a line is a fundamental concept in mathematics, representing the steepness and direction of a straight line. It quantifies how much the y-value changes for every unit change in the x-value. Understanding slope is crucial for various mathematical operations, including writing linear equations, analyzing graphs, and solving real-world problems involving linear relationships. Calculating the Slope: **The slope, typically denoted by 'm', is calculated using the following formula:**

$m = (y_2 - y_1) / (x_2 - x_1)$ where (x_1, y_1) and (x_2, y_2) are any two distinct points on the line. This formula represents the change in y (rise) divided by the change in x (run). Let's illustrate with an example: Consider two points on a line: A(2, 4) and B(6, 10). Using the formula: $m = (10 - 4) / (6 - 2) = 6 / 4 = 3/2$ Therefore, the slope of the line passing through points A and B is $3/2$. This means that for every 2 units increase in the x-value, the y-value increases by 3 units. | Point (x, y) | x-coordinate | y-coordinate | ||| | A | 2 | 4 | | B | 6 | 10 |

Different Types of Slopes: The slope of a line can be positive, negative, zero, or undefined, each indicating a specific characteristic of the line's direction:

• **Positive Slope:** A positive slope indicates that the line rises from left to right. As the x-value increases, the y-value also increases. The example above ($m = 3/2$) demonstrates a positive slope.

• **Negative Slope:** A negative slope indicates that the line falls from left to right. As the x-value increases, the y-value decreases. For example, a line passing through (1, 5) and (3, 1) would have a slope of $(1-5)/(3-1) = -2$.

• **Zero Slope:** A horizontal line has a slope of zero. In this case, the change in y is always zero, regardless of the change in x. The equation of a horizontal line is always $y = \text{constant}$.

• **Undefined Slope:** A vertical line has an undefined slope. This is because the change in x is always zero, resulting in division by zero, which is not allowed in mathematics. The equation of a vertical line is always $x = \text{constant}$.

Illustrative Chart:

Type of Slope	Description	Example Points	Slope (m)	Visual Representation
Positive	Rises from left to right	(1,2), (3,4)	1	/ /
Negative	Falls from left to right	(1,4), (3,2)	-1	\ \
Zero	Horizontal line	(1,2), (4,2)	0	
Undefined	Vertical line	(2,1), (2,4)	Undefined	

Understanding Linear Equations and Slope

The slope is a crucial component of the slope-intercept form of a linear equation: $y = mx + b$ **where:** • '**m**' is the slope • '**b**' is the y-intercept (the point where the line crosses the y-axis). **Knowing the slope and y-intercept allows you to easily graph a linear equation. For example, if the equation is $y = 2x + 1$, the slope is 2 and the y-intercept is 1.**

Slope and Graph Interpretation

The slope can be visually determined from a graph by selecting two points on the line and calculating the ratio of the vertical change to the horizontal change between those points. This is often referred to as "rise over run." The steeper the line, the greater the absolute value of the slope.

Applications of Slope in Real-World Problems

Slope finds practical applications in various fields: • Engineering: *Calculating the grade of a road or the angle of a ramp.* • Physics: **Determining the velocity of an object from a distance-time graph (velocity is the slope of the distance-time graph).** • Economics: **Analyzing the relationship between price and demand (slope of the demand curve).** • Finance: Calculating the rate of return on an investment.

Related Topics:

Parallel and Perpendicular Lines:

Parallel lines have the same slope. Perpendicular lines have slopes that are negative reciprocals of each other. For example, if one line has slope '**m**', a perpendicular line will have a slope of '**-1/m**'.

Finding the Equation of a Line:

Given the slope and one point on the line, you can use the point-slope form of the equation to find the equation of the line: $y - y_1 = m(x - x_1)$ **where (x_1, y_1) is the known point and '**m**' is the slope. This equation can then be rearranged into slope-intercept form.** Conclusion: *The slope of a line is a fundamental concept in mathematics with widespread applications. Understanding how to calculate and interpret slope is essential for mastering linear equations, analyzing graphs, and solving real-world problems involving linear relationships. By understanding the different types of slopes and their applications, you can develop a strong foundation in mathematics for further advancement.* FAQs: **1. What does a slope of 1 mean? A slope of 1 means that for every one unit increase in the x-value, the y-value increases by one unit. The**

line forms a 45-degree angle with the x-axis. 2. Can the slope of a line be a decimal? **Yes, the slope can be any real number, including decimals and fractions.** 3. How does the slope relate to the angle of inclination? The slope is the tangent of the angle of inclination of the line with the positive x-axis. 4. What if I only have one point on the line? You cannot determine the slope of a line with only one point. You need at least two points. 5. How is slope used in calculus? Slope is a fundamental concept in calculus, where it forms the basis of derivatives, which measure the instantaneous rate of change of a function.

What Exactly IS the Slope of a Line? A Deep Dive for Everyone

Ever looked at a graph and wondered how steep that line is? Or maybe you've heard math teachers talk about "rise over run" and felt a bit lost. Don't worry, you're not alone! The concept of the slope of a line is fundamental in mathematics, and understanding it unlocks a whole new level of comprehension for everything from basic algebra to advanced calculus. Today, we're going to break down the definition of slope in math, demystify its formulas, and explore why it's so incredibly useful. Think of slope as the "steepness" or "rate of change" of a line. It tells us how much the vertical position (y-value) changes for every unit of horizontal movement (x-value). Whether you're dealing with the incline of a hill, the speed of a car, or the growth rate of a population, the concept of slope is often at play.

The Intuitive Definition: Rise Over Run

The most intuitive way to grasp slope is through the phrase "rise over run." Imagine you're walking along a line on a graph. **Run:** This is your horizontal movement. How many steps do you take to the right (or left)? This corresponds to the change in the x-coordinates. **Rise:** This is your vertical movement. How many steps do you take up (or down)? This corresponds to the change in the y-coordinates. So, the slope is simply the ratio of how much you "rise" (change in y) for every unit you "run" (change in x). A positive slope means the line is going uphill as you move from left to right. A negative slope means it's going downhill. A slope of zero indicates a perfectly horizontal line, and an undefined slope signifies a vertical line.

Formalizing the Definition: The Slope Formula

While the "rise over run" idea is great for understanding, mathematicians have a precise formula for calculating slope. Let's say we have two points on a line: Point 1 with coordinates (x_1, y_1) and Point 2 with coordinates (x_2, y_2) . The change in y (the rise) is calculated as: $\Delta y = y_2 - y_1$ The change in x (the run) is calculated as: $\Delta x = x_2 - x_1$

The slope, often represented by the letter ***m***, is then defined as:

$$m = \Delta y / \Delta x = (y_2 - y_1) / (x_2 - x_1)$$

This formula is the cornerstone of understanding slope. It's crucial to remember that the order of subtraction matters. If you subtract y_1 from y_2 , you must subtract x_1 from x_2 . Consistency is key!

What Different Slope Values Mean

The value of ' m ' tells us a lot about the line: **Positive Slope ($m > 0$)**: The line ascends from left to right. The larger the positive value, the steeper the incline. Think of climbing a mountain – a higher slope means a harder climb! **Negative Slope ($m < 0$)**: The line descends from left to right. The more negative the value (e.g., -5 is steeper than -1), the steeper the decline. Imagine skiing down a slope – a steeper negative slope means faster descent. **Zero Slope ($m = 0$)**: The line is perfectly horizontal. The y -values don't change as the x -values do. This is like walking on flat ground – no uphill or downhill. **Undefined Slope**: This occurs when the denominator (Δx) in the slope formula is zero. This happens with vertical lines. Since you can't divide by zero, the slope is considered undefined. A vertical line represents an infinitely steep incline.

Visualizing Slope: From Graphs to Real Life

Graphs are the most direct way to visualize slope. A line with a steep positive slope will shoot upwards quickly from left to right. A line with a gentle positive slope will rise more gradually. Similarly, steep negative slopes plummet downwards, while gentle negative slopes descend more slowly. But slope isn't just confined to mathematical graphs. It's everywhere! **Construction and Engineering**: Builders use slope to design roofs that shed water, ramps for accessibility, and the gradients of roads. A road with a high slope is a challenge for cyclists and drivers! **Economics**: Economists use slope to represent the rate of change in supply and demand, or the marginal cost of production. A steep demand curve, for instance, shows a rapid drop in sales as price increases. **Physics**: Velocity is the slope of a position-time graph. Acceleration is the slope of a velocity-time graph. These are critical concepts in understanding motion. **Environmental Science**: The rate of deforestation or the spread of a disease can be modeled using slope. A rapid increase in cases (a steep positive slope) requires immediate action.

Slope in Different Forms of Linear Equations

The definition of slope is intricately linked to the equations that represent lines. You'll often encounter slope within various linear equation forms:

Slope-Intercept Form: $y = mx + b$

This is arguably the most common and user-friendly form for understanding slope. In the equation $y = mx + b$, m is the slope of the line. b is the y-intercept, which is the point where the line crosses the y-axis (where $x = 0$). This form makes it incredibly easy to identify the slope just by looking at the equation! For example, in the equation $y = 3x + 2$, the slope (m) is 3. This tells us that for every 1 unit increase in x , y increases by 3 units.

Point-Slope Form: $y - y_1 = m(x - x_1)$

This form is useful when you know the slope of a line and one point it passes through. Again, m represents the slope. This form directly incorporates the slope into the equation, allowing you to derive the slope-intercept form or graph the line.

Standard Form: $Ax + By = C$

In standard form, identifying the slope isn't as immediate as in slope-intercept form. You'll need to rearrange the equation to solve for 'y' and get it into the $y = mx + b$ format. To do this, we can isolate the 'By' term: $By = -Ax + C$. Then, divide by 'B' to get 'y' by itself: $y = (-A/B)x + (C/B)$. Now, you can see that the slope (m) in standard form is $-A/B$. This is a handy shortcut to remember!

Special Cases: Horizontal and Vertical Lines

We touched on these earlier, but they're worth reiterating because they represent unique scenarios for slope.

Horizontal Lines: Slope is Zero

A horizontal line has an equation of the form $y = k$, where 'k' is a constant. For example, $y = 5$. Let's pick two points on this line: (1, 5) and (3, 5). Using the slope formula: $m = (5 - 5) / (3 - 1) = 0 / 2 = 0$. As you can see, the y-values are the same, leading to a rise of zero, and therefore a slope of zero.

Vertical Lines: Slope is Undefined

A vertical line has an equation of the form $x = h$, where 'h' is a constant. For example, $x = 2$. Let's pick two points on this line: (2, 1) and (2, 4). Using the slope formula: $m = (4 - 1) / (2 - 2) = 3 / 0$. Since we cannot divide by zero, the slope is undefined. The x-values are the same, meaning there's no "run," and the line is infinitely steep.

The Importance of Slope in Mathematical Concepts

Understanding the definition of slope is not just about memorizing a formula. It's about grasping a fundamental concept that underpins many areas of mathematics:

- Linear Functions:** Slope is the defining characteristic of linear functions. It dictates their behavior and how they change.
- Calculus:** Derivatives, a core concept in calculus, are essentially the instantaneous slope of a curve at a specific point.
- Geometry:** Slope helps in determining if lines are parallel (same slope), perpendicular (slopes are negative reciprocals), or intersecting.
- Data Analysis:** Slope is used to find trends and relationships in data sets, allowing us to make predictions and draw conclusions.

In Conclusion: Mastering the Concept of Slope

So, there you have it! The definition of slope of a line in math is much more than just a number. It's a powerful descriptor of a line's steepness, direction, and rate of change. From the simple "rise over run" to the precise formula $m = (y_2 - y_1) / (x_2 - x_1)$ and its appearances in various equation forms, slope is a concept that, once understood, will make navigating the world of mathematics significantly easier and more intuitive. Keep practicing, visualizing, and looking for slope in the world around you – you'll be surprised at how often it appears!

The slope of a line is a fundamental concept in mathematics that captures the rate at which one quantity changes in relation to another. At its core, it measures how steep a line appears on a coordinate plane—how rapidly the vertical value (the y-coordinate) increases or decreases as the horizontal value (the x-coordinate) increases. Defined mathematically, the slope quantifies the ratio of the vertical change, known as the rise, to the horizontal change, referred to as the run, between any two distinct points lying on the same straight line.

To grasp this idea fully, imagine standing on a graph where the x-axis represents time and the y-axis represents distance. As time passes, the distance traveled typically changes at a constant rate, and the slope of the resulting line reflects that consistent rate. If the line rises steeply, the slope is positive and large, indicating rapid growth. Conversely, a gently sloping line with a small positive slope shows slow, steady progress, while a negative slope indicates decline—such as a stock price dropping over time or a temperature falling during winter. A horizontal line, with zero slope, shows no change at all, meaning the quantity remains constant regardless of the x-value.

Understanding the Slope Formula

The slope is formally calculated using the formula $m = \text{rise over run}$, or mathematically expressed as $m = (y_2 - y_1) \div (x_2 - x_1)$, where (x_1, y_1) and (x_2, y_2) are any two points on the line. This formula not only provides a numeric value but also reveals critical

information about the line's behavior. A positive slope means that as x increases, y increases—graphs exhibiting this are known as direct variation lines. A negative slope indicates an inverse relationship: as x grows, y decreases, forming a decreasing line. When the slope is zero, the line remains flat, reflecting a horizontal path with no vertical movement. The undefined slope occurs when the line is vertical, where horizontal change (run) is zero, making division impossible and thus the slope undefined in real numbers.

Beyond its theoretical definition, the slope holds immense practical significance across numerous disciplines. In physics, slope represents velocity or acceleration, helping scientists model motion and forces. In economics, it helps analyze trends such as cost per unit or rate of return, enabling data-driven decisions. Engineers rely on slope calculations to design safe and efficient structures, from road gradients to hydraulic systems. In everyday life, understanding slope aids in interpreting graphs in weather reports, stock charts, and even fitness tracking, where pace and progress are key.

Benefits and Educational Value

Grasping the concept of slope enhances logical reasoning and problem-solving skills. It forms the basis for more advanced topics in algebra, calculus, and geometry, making it an indispensable building block in mathematics education. Mastering slope helps students visualize relationships between variables, interpret real-world data accurately, and communicate mathematical ideas clearly. This foundational knowledge supports analytical thinking, preparing learners to tackle complex quantitative challenges in science, business, and technology.

Looking ahead, the importance of slope continues to grow in an increasingly data-driven world. As artificial intelligence and machine learning systems rely heavily on pattern recognition and predictive modeling, understanding linear relationships and slope remains vital. These systems often analyze large datasets where linear trends reveal underlying structures, enabling forecasts in finance, climate science, and public health. Moreover, educational tools are evolving to visualize slope dynamically, making abstract concepts tangible through interactive graphs and simulations, fostering deeper comprehension from an early age.

The Future of Slope in Learning and Application

The future of teaching and applying slope lies in making it intuitive, accessible, and connected to real-life contexts. Educators are embracing technology to transform static formulas into dynamic visualizations, helping students explore how changing one variable affects another in real time. This hands-on approach deepens understanding and sparks curiosity. As mathematical literacy becomes ever more essential, the slope remains a powerful lens through which we interpret change—bridging numbers, graphs,

and the world around us with clarity and purpose.

Unveiling the Definition of Slope of a Line in Math: A Deep Dive into Inclination

In the realm of mathematics, the concept of a "line" is fundamental. We encounter lines everywhere, from the simplest graphs to the most complex geometric constructions. But a line isn't just a collection of points; it possesses a crucial characteristic that defines its direction and steepness: its slope. Understanding the **definition of slope of a line in math** is not merely about memorizing a formula; it's about grasping a core principle that unlocks a deeper understanding of linear relationships, rates of change, and graphical representations.

This article will embark on a comprehensive exploration of the slope of a line, dissecting its definition, illustrating its calculation, and highlighting its profound significance across various mathematical and scientific disciplines. We will delve into what makes a line steep or flat, positive or negative, and how this single numerical value encapsulates so much information about its trajectory.

What is the Slope of a Line?

At its most intuitive level, the **slope of a line** represents how steeply inclined a line is with respect to the horizontal axis. Think of it as a measure of "rise over run." If you were to walk along a line, the slope would tell you how much you ascend or descend for every unit you move horizontally. This "rise" is the change in the vertical direction (y-axis), and the "run" is the change in the horizontal direction (x-axis).

The Formal Mathematical Definition

Mathematically, the slope of a non-vertical line is defined as the ratio of the change in the y-coordinates (the "rise") to the change in the x-coordinates (the "run") between any two distinct points on the line. If we have two points on a line, P1 with coordinates (x1, y1) and P2 with coordinates (x2, y2), the slope, typically denoted by the letter '**m**', is calculated as:

$$m = (y2 - y1) / (x2 - x1)$$

Here:

1. **y2 - y1** represents the vertical change, or the "rise."
2. **x2 - x1** represents the horizontal change, or the "run."

It's crucial to remember that the order of subtraction matters. If you subtract y1 from y2, you must subtract x1 from x2 in the denominator. Similarly, if you subtract y2 from

y_1 , you must subtract x_2 from x_1 .

Understanding the Components: Rise and Run

The terms "rise" and "run" are incredibly helpful in visualizing the slope. Imagine a right-angled triangle formed by the two points and the horizontal and vertical segments connecting them. The rise is the length of the vertical leg, and the run is the length of the horizontal leg. The slope is essentially the tangent of the angle the line makes with the positive x-axis.

Interpreting the Value of Slope

The numerical value of the slope provides significant insights into the line's behavior. Its sign and magnitude are key to its interpretation.

Positive Slope: Ascending Lines

A **positive slope** indicates that as you move from left to right along the line, the y-values increase. The line is ascending or going upwards. The larger the positive value, the steeper the upward inclination. For instance, a slope of 2 means that for every 1 unit you move to the right, the line goes up by 2 units.

Negative Slope: Descending Lines

A **negative slope** signifies that as you move from left to right, the y-values decrease. The line is descending or going downwards. The more negative the value, the steeper the downward inclination. A slope of -3 means that for every 1 unit you move to the right, the line goes down by 3 units.

Zero Slope: Horizontal Lines

If the numerator ($y_2 - y_1$) is zero, meaning the y-coordinates of the two points are the same, the slope is 0. This indicates a **horizontal line**. A horizontal line has no vertical change for any horizontal change, meaning it's perfectly flat and parallel to the x-axis. In this case, $y_1 = y_2$, so $m = 0 / (x_2 - x_1) = 0$.

Undefined Slope: Vertical Lines

If the denominator ($x_2 - x_1$) is zero, meaning the x-coordinates of the two points are the same, the slope is undefined. This occurs with **vertical lines**. A vertical line has an infinite steepness, and mathematically, division by zero is undefined. In this scenario, $x_1 = x_2$, so $m = (y_2 - y_1) / 0$, which is an undefined operation.

The Magnitude of Slope: Steepness

The absolute value of the slope indicates the steepness of the line. A slope of 5 is steeper than a slope of 2. Similarly, a slope of -5 is steeper than a slope of -2. A slope of 1 or -1 represents a line that makes a 45-degree angle with the x-axis.

Calculating the Slope: Practical Examples

Let's illustrate the calculation of slope with some practical examples.

Example 1: Finding Slope from Two Points

Consider two points on a line: A(2, 3) and B(5, 9).

Here, $x_1 = 2$, $y_1 = 3$, $x_2 = 5$, and $y_2 = 9$.

Using the slope formula:

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

$$m = (9 - 3) / (5 - 2)$$

$$m = 6 / 3$$

$$m = 2$$

The slope of the line passing through points A and B is 2. This positive slope indicates that the line is ascending.

Example 2: Calculating Slope with Negative Coordinates

Let's take points C(-1, 4) and D(3, -2).

Here, $x_1 = -1$, $y_1 = 4$, $x_2 = 3$, and $y_2 = -2$.

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

$$m = (-2 - 4) / (3 - (-1))$$

$$m = -6 / (3 + 1)$$

$$m = -6 / 4$$

$$m = -3/2$$

The slope is -3/2. This negative slope indicates a descending line.

Example 3: Horizontal and Vertical Lines

For a horizontal line passing through (1, 5) and (7, 5):

$$m = (5 - 5) / (7 - 1) = 0 / 6 = 0. \text{ The slope is 0.}$$

For a vertical line passing through (3, 2) and (3, 8):

$m = (8 - 2) / (3 - 3) = 6 / 0$. The slope is undefined.

The Slope in the Context of Linear Equations

The definition of slope is intrinsically linked to the standard form of linear equations.

One of the most common forms is the **slope-intercept form**:

$$y = mx + b$$

In this equation:

1. 'm' directly represents the slope of the line.
2. 'b' represents the y-intercept, which is the point where the line crosses the y-axis (where $x = 0$).

This form makes it incredibly easy to identify the slope and y-intercept of a line simply by looking at its equation. If an equation is not in this form, algebraic manipulation can often transform it to reveal the slope.

Point-Slope Form

Another important form is the **point-slope form**, which is derived directly from the slope definition:

$$y - y_1 = m(x - x_1)$$

This form is particularly useful when you know the slope of a line and the coordinates of a single point on that line. It directly incorporates the slope 'm' and the point (x1, y1).

Why is the Slope of a Line Important?

The concept of slope extends far beyond simple graphical representation. Its importance is felt across numerous fields.

Rate of Change

Perhaps the most profound application of slope is its representation of a **rate of change**. In physics, for example, velocity is the rate of change of displacement with respect to time. If you plot displacement on the y-axis and time on the x-axis, the slope of the resulting graph represents the velocity. Similarly, in economics, the slope can represent the rate of inflation, the marginal cost, or the elasticity of demand.

Predictive Modeling

Linear regression, a powerful statistical technique, uses the concept of slope to find the

best-fitting line through a set of data points. This line can then be used to make predictions about future trends. The slope in this context quantifies the average change in the dependent variable for a unit change in the independent variable.

Geometry and Trigonometry

In geometry, the slope helps determine if lines are parallel (have the same slope) or perpendicular (have slopes that are negative reciprocals of each other). In trigonometry, as mentioned earlier, the slope is directly related to the tangent of the angle a line makes with the positive x-axis.

Real-World Applications

From calculating the incline of a road or a roof to understanding the growth rate of a population or the depreciation of an asset, the principles of slope are woven into our everyday lives and the analysis of complex systems.

Common Pitfalls and Key Takeaways

While the definition of slope is straightforward, some common mistakes can occur:

1. **Incorrectly identifying the "rise" and "run":** Always ensure you are consistently calculating the change in y over the change in x.
2. **Mixing up the order of subtraction:** Maintain the same order for both numerator and denominator.
3. **Confusing horizontal and vertical lines:** Remember that horizontal lines have a slope of 0, while vertical lines have an undefined slope.

In summary, the **definition of slope of a line in math** is a powerful tool that quantifies the steepness and direction of a line. By understanding the "rise over run" concept and how to calculate and interpret its value, we gain a fundamental insight into linear relationships, rates of change, and the graphical representation of data. Mastering the slope is a crucial step in building a strong foundation in algebra, calculus, and numerous other scientific and analytical disciplines.

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Questions & Answers About definition of slope of a line in math

No	Question	Answer
1	What's the simplest way to explain slope to someone who's never heard of it?	Think of slope as how steep a line is. It tells you how much the line goes up or down for every step it takes to the right.
2	How do you actually calculate the slope of a line if you have two points on it?	You find the difference in the 'y' values (the 'rise') and divide it by the difference in the 'x' values (the 'run'). So, $\text{slope} = (y_2 - y_1) / (x_2 - x_1)$.
3	Does a positive or negative slope mean something different visually?	Yes! A positive slope means the line goes upwards as you move from left to right (like climbing a hill). A negative slope means the line goes downwards (like going downhill).
4	What happens to the slope if the line is perfectly flat or perfectly vertical?	A perfectly flat horizontal line has a slope of zero because there's no 'rise'. A perfectly vertical line has an undefined slope because you can't divide by zero when calculating the 'run'.
5	Why is understanding slope so important in math and real life?	Slope is crucial for understanding rates of change. In math, it helps describe relationships between variables. In real life, it's used in everything from construction and physics to economics and graphing data.
6	Can you give an example of slope in everyday life?	Imagine a ramp. The steepness of the ramp is its slope. A steeper ramp has a higher slope, meaning you go up a greater vertical distance for a given horizontal distance.

slope of a line formula, definition of slope in math, how to calculate slope of a line, slope meaning in geometry, slope interpretation in linear equations, slope of a straight line

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