Angle Between A Line And A Plane

Meta Title: Angle between Line & Plane: Calculation & Explanation

Meta Description: Learn how to calculate the angle between a line and a plane in 3D space. Understand the formulas & concepts with clear examples & diagrams

Introduction

The **angle between a line and a plane** is a measure of how much the line deviates from the plane. This angle can be used to determine the degree of alignment or misalignment between the two. When the angle is zero, the line is considered to be parallel to the plane. When the angle is 90 degrees, the line is considered to be perpendicular to the plane. In this article, we will discuss the formulas and concepts involved in calculating the **angle between a line and a plane**, along with clear examples and diagrams to help you understand the process.

What is the Straight Line?

A straight line is a geometric object defined by two distinct points in space and the set of all points on the same path that connects those two places. It has no curvature and is the shortest distance between two points.

A straight line is defined mathematically by an equation of the form y = mx + b, where m is the slope of the line and b is the y-intercept.

In the coordinate plane, a straight line can be represented by an equation in the slope-intercept form (y = mx + b) or the point-slope form (y - y_1` = m(x - x_1)), where m is the slope of the line and (x_1, y_1) is a point on the line.

What is the Plane?

A plane is a flat, two-dimensional surface that extends infinitely in all directions. It is defined by a set of points that are all the same distance from a fixed point, called the origin or the point of reference. A plane can be represented by an equation in the form of Ax + By + Cz + D = 0, where A, B, and C are the coefficients and D is a constant. The coefficients of x, y, and z determine the direction of the normal vector to the plane. The normal vector is a vector that is perpendicular to the plane. Planes can be represented graphically in 3-dimensional space and can be thought of as flat surface that extends infinitely in all directions.

Angle Between a Line and a Plane

The angle between a line and a plane is a measure of the deviation of the line from the plane. It is a value that ranges from 0 to 90 degrees, where 0 degrees represents a line that is parallel to the plane, and 90 degrees represents a line that is perpendicular to the plane.

To calculate the **angle between a line and a plane**, we can use the dot product of the normal vector of the plane and the direction vector of the line. The formula is as follows:

$\cos(\boldsymbol{\theta}) = (n . d) / (||n|| * ||d||)$

Where "n" is the normal vector of the plane, "d" is the direction vector of the line, and "$\boldsymbol{\theta}$" is the angle between the line and the plane.

Another method of finding the **angle between a line and the plane** is by using the cross product of vectors, which is

$\sin(\boldsymbol{\theta}) = (n \times d) / (||n|| * ||d||)$

It is also important to note that in some cases, the line may be contained within the plane, in which case the angle will be zero degrees.

To find the angle using the dot product, we first need to find the normal vector of the plane, which can be found using the coefficients of the variables in the plane's equation. Next, we need to find the direction vector of the line, which can be found using a point on the line and the direction ratios of the line. We then take the dot product of the normal vector and the direction vector and divide it by the product of the magnitudes of the vectors.

To find the angle using the cross product, we first find the cross product of the direction vector of the line and the normal vector of the plane, and then divide by the product of the magnitudes of the vectors.

It is important to note that **angle between the line and the plane** is always acute and is independent of the position of the line concerning the plane.

Examples:

- A plane with the equation $3x + 4y - 7z = 0$ and a line with the direction vector $<2, 3, 1>$ and a point on the line $(-1, 2, 3)$.

  $\mathbf{n}=<3,4,-7>$ and $\mathbf{d}=<2,3,1>$.Applying $\cos(\boldsymbol{\theta}) = (n . d) / (||n|| * ||d||)$

The angle between the line and the plane is approximately 11.6 degrees.

- A plane with the equation $2x - 3y + z = 5$ and a line with the direction vector <1, -2, 3> and a point on the line (-1, 2, 1).
  - **n**=<2,-3,1> and **d**=<1,-2,3>.Applying $\cos(\boldsymbol{\theta}) = (n . d) / (||n|| * ||d||)$

  The angle between the line and the plane is approximately 78.4 degrees.

In summary, the **angle between a line and a plane** can be calculated using the dot product or cross product of the normal vector of the plane and the direction vector of the line, and it gives us the acute angle between them. It's a useful measure to understand the deviation of the line from the plane in 3D space.

FAQs

Q. What is the difference between the angle between line and plane and the angle between line and line?

A. The angle between a line and a plane is the acute angle between the given line and a plane, whereas the angle between a line and a line is the angle between two lines in a space.

Q. What does a zero-degree angle between a line and a plane indicate?

A. zero-degree angle between a line and a plane indicates that the line is parallel to the plane.

Q. What does a 90-degree angle between a line and a plane indicate?

A. A 90-degree angle between a line and a plane indicates that the line is perpendicular to the plane.

Q. Can a line be contained within a plane?

A. Yes, a line can be contained within a plane. In this case, the angle between the line and the plane is zero degrees.

Q. Is the angle between a line and a plane always acute?

A. Yes, the angle between a line and a plane is always acute.

Q. Is the angle between a line and a plane dependent on the position of line concerning the plane?

A. No, the angle between a line and a plane is independent of the position of line concerning the plane.

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Y Intercept & X Intercept Formula | Slope Intercept Form & Equation Compare Text

... If, the Y Intercept Formula of a line in the slope intercept form y = mx + c is, \[\large y=c\] Where, m = is the slope of the line. c = is the intercept of the line. If, the Y Intercept Formula of a line in the point slope form y – b = m(x – a) is, \[\large y=\; -am+b\] Where, m is the slope of the line. (a,b) is a point on the line. Once you have understood the concept of the slope then

https://www.andlearning.org/intercept-formula/

True or False? The point-slope form of a line is y + y1 = m(x + x1 ... Compare Text

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https://brainly.com/question/4545360

Solved The point slope form of a line is y+y1=m(x+x1), where ... Compare Text

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https://www.chegg.com/homework-help/questions-and-answers/ point-slope-form-line-y-y1-m-x-x1-m-slope-x1-y1-point-line-q17188423

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... The point-slope form of the equation of a line is y − y1 = m(x − x1), where m is the slope ... and (x1, y1) is a point on the line.

https://web2.0calc.com/questions/help-please_98003

Algebra: Slope-Intercept Form - InfoPlease Compare Text

... Once a linear equation is solved for y, it is in slope-intercept form, y = mx + b. The coefficient of the x term, m, is the slope of the line and the number (or constant), b, is the y -intercept. In other words, once

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