

how calculate the angle of 3d vector

To calculate the angle between two 3D vectors, use the **dot product formula**, which extends naturally from 2D to 3D. Here's the step-by-step method:

Step 1: Formula Overview

The angle

$$\theta$$

between vectors

$$\mathbf{a} = (a_x, a_y, a_z)$$

and

$$\mathbf{b} = (b_x, b_y, b_z)$$

is given by:

$$\theta = \cos^{-1} \left(\frac{\mathbf{a} \cdot \mathbf{b}}{|\mathbf{a}| |\mathbf{b}|} \right)$$

where:

- (dot product)

$$\mathbf{a} \cdot \mathbf{b} = a_x b_x + a_y b_y + a_z b_z$$

- (magnitude of
 \mathbf{a}
)

$$|\mathbf{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$$

- (magnitude of
 \mathbf{b}
) [\[1\]](#) [\[2\]](#) [\[3\]](#)

$$|\mathbf{b}| = \sqrt{b_x^2 + b_y^2 + b_z^2}$$

Step 2: Worked Example

Problem: Find the angle between vectors

$$\mathbf{a} = (3, 6, 1)$$

and

$$\mathbf{b}$$

, where

$$\mathbf{b}$$

is the vector from point

$$A = (1, 1, 2)$$

to

$$B = (-4, -8, 6)$$

.

1. Calculate

$$\mathbf{b}$$

:

$$\mathbf{b} = B - A = (-4 - 1, -8 - 1, 6 - 2) = (-5, -9, 4)$$

2. Compute the dot product:

$$\mathbf{a} \cdot \mathbf{b} = (3)(-5) + (6)(-9) + (1)(4) = -15 - 54 + 4 = -65$$

3. Find magnitudes:

$$|\mathbf{a}| = \sqrt{3^2 + 6^2 + 1^2} = \sqrt{46} \approx 6.782$$

$$|\mathbf{b}| = \sqrt{(-5)^2 + (-9)^2 + 4^2} = \sqrt{122} \approx 11.045$$

4. Calculate

$$\cos(\theta)$$

:

$$\cos(\theta) = \frac{-65}{\sqrt{46} \cdot \sqrt{122}} \approx \frac{-65}{74.97} \approx -0.867$$

5. Find

$$\theta$$

:

$$\theta = \cos^{-1}(-0.867) \approx 150.2^\circ$$

The angle is approximately **150.2°**^[2] ^[3].

Key Notes:

- The result is always between

$$0^\circ$$

and

$$180^\circ$$

, as the arccosine function returns the smallest angle^[4].

- For vectors defined between points (e.g.,

$$A$$

and

$$B$$

), subtract coordinates to get the vector components first^[2].

Summary

For two 3D vectors:

1. Compute their dot product.
2. Divide by the product of their magnitudes.

3. Take the arccosine of the result.

This method works universally for any pair of 3D vectors, whether defined directly or via points in space.



1. <https://www.youtube.com/watch?v=dYPRYO8QhxU>
2. <https://www.omnicalculator.com/math/angle-between-two-vectors>
3. <https://www.cuemath.com/geometry/angle-between-vectors/>
4. <https://stackoverflow.com/questions/39497496/how-do-i-retrieve-the-angle-between-two-vectors-3d>