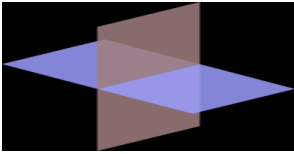


## Angle between two planes

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## Angle between two planes - Introduction



The [angle](#) between two planes is defined as the angle between their normals. If  $\theta$  is the angle between two planes, then so is  $180 - \theta$ . We shall take the acute angle as the [angle between two planes](#).

**Vector Form:** If  $\vec{r} \cdot \vec{n}_1 = d_1$  and  $\vec{r} \cdot \vec{n}_2 = d_2$  are the equations of two planes then angle between them is given by the equation

$$\cos \theta = \left| \frac{\vec{n}_1 \cdot \vec{n}_2}{|\vec{n}_1| |\vec{n}_2|} \right|$$

$$\theta = \cos^{-1} \left[ \frac{\vec{n}_1 \cdot \vec{n}_2}{|\vec{n}_1| |\vec{n}_2|} \right]$$

**Cartesian Form:** If  $A_1x + B_1y + C_1z + D_1 = 0$  and  $A_2x + B_2y + C_2z + D_2 = 0$  are the Cartesian equations of two planes and  $\theta$  is the angle between them then

$$\cos \theta = \left| \frac{A_1A_2 + B_1B_2 + C_1C_2}{\sqrt{A_1^2 + B_1^2 + C_1^2} \sqrt{A_2^2 + B_2^2 + C_2^2}} \right|$$

### Condition for parallelism and perpendicularity

- $$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$
1. If the planes are parallel then
  2. If the planes are perpendicular then  $A_1A_2 + B_1B_2 + C_1C_2 = 0$

### Coplanarity of Two Lines

**Vector Form:** If  $\vec{r} = \vec{a}_1 + \lambda \vec{b}_1$  and  $\vec{r} = \vec{a}_2 + \mu \vec{b}_2$  are the equations of two lines then they are said to be coplanar if  $(\vec{a}_2 - \vec{a}_1) \cdot (\vec{b}_1 \times \vec{b}_2) = 0$

**Cartesian Form:** If  $A(x_1, y_1, z_1)$  and  $B(x_2, y_2, z_2)$  are two points with the direction ratios of parallel [vectors](#)  $\langle a_1, b_1, c_1 \rangle$  and  $\langle a_2, b_2, c_2 \rangle$ , then the lines are said to be coplanar if

$$\begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix} = 0$$

## Distance of a point from a plane

**Vector Form:** If the equation of the plane is in the form  $\vec{r} \cdot \vec{N} = d$ , where  $\vec{N}$  is normal to the plane, then the perpendicular [distance](#) is 
$$\frac{|\vec{a} \cdot \vec{N} - d|}{|\vec{N}|}$$

The length of perpendicular from origin O to the plane  $\vec{r} \cdot \vec{N} = d$  is  $|d|/|\vec{N}|$

**Cartesian Form:** If  $P(x_1, y_1, z_1)$  be the given point with position vector  $\vec{a}$  and  $Ax + By + Cz = D$  be the equation of the plane then the perpendicular distance from P to the plane is given by 
$$d = \left| \frac{Ax_1 + By_1 + Cz_1 - D}{\sqrt{A^2 + B^2 + C^2}} \right|$$

## Angle between a Line and a Plane

If  $\vec{r} = \vec{a} + \lambda \vec{b}$  be the equation of the line and  $\vec{r} \cdot \vec{n} = d$  be the equation of the plane the angle between them is given by

$$\sin \Phi = \left| \frac{\vec{b} \cdot \vec{n}}{|\vec{b}| |\vec{n}|} \right|$$

$$\Phi = \sin^{-1} \left( \frac{|\vec{b} \cdot \vec{n}|}{|\vec{b}| |\vec{n}|} \right)$$

**Example:** Find the distance of a point (2, 5, -3) from the plane  $6x - 3y + 2z - 4 = 0$

$$d = \frac{|6 \times 2 - 3 \times 5 + 2 \times (-3) - 4|}{\sqrt{36 + 9 + 4}}$$

**Solution:** Distance

$$= \frac{|12 - 15 - 6 - 4|}{\sqrt{49}}$$

$$= 13/7$$

Now try it yourself! Should you still need any help,[click here](#) to schedule live online session with e Tutor!

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## Links:

- [http://en.wikipedia.org/wiki/Angle#Angles\\_between\\_curves](http://en.wikipedia.org/wiki/Angle#Angles_between_curves)
- [http://schools-wikipedia.org/wp/p/Plane\\_%2528mathematics%2529.htm](http://schools-wikipedia.org/wp/p/Plane_%2528mathematics%2529.htm)
- <http://www.netcomuk.co.uk/~jenolive/vect>
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