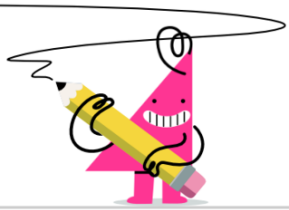
Name



Planes in 3D Space - Intro

1 State the normal vector of the plane.

$$4x - 2y + 2z = 4$$

A $\begin{pmatrix} 2 \\ 4 \\ -2 \end{pmatrix}$

B $\begin{pmatrix} 4 \\ -2 \\ 4 \end{pmatrix}$

C $\begin{pmatrix} -4 \\ 2 \\ -2 \end{pmatrix}$

D $\begin{pmatrix} 4 \\ -2 \\ 2 \end{pmatrix}$

2 Write a possible scalar equation of a plane with the given normal vector.

$$\vec{n} = \begin{pmatrix} 4 \\ 0 \\ 3 \end{pmatrix}$$

A $3x + 4y = -8$

B $-4x - 3z = -8$

C $5x - y + 3z = -8$

D $4x + 3z = -8$

3 State a point that lies on the plane.

$$\vec{r} = \begin{pmatrix} -3 \\ 1 \\ 2 \end{pmatrix} + s \begin{pmatrix} 3 \\ 2 \\ -3 \end{pmatrix} + t \begin{pmatrix} -3 \\ 4 \\ 4 \end{pmatrix}$$

A $(0,\ 6,\ 1)$

B $(-3,\ 4,\ 4)$

C $(3,\ 2,\ -3)$

D $(-3,\ 1,\ 2)$

4 Which vector is parallel to the plane?

$$\vec{r} = \begin{pmatrix} 1 \\ 1 \\ -1 \end{pmatrix} + s \begin{pmatrix} -3 \\ 3 \\ 3 \end{pmatrix} + t \begin{pmatrix} 0 \\ -3 \\ -3 \end{pmatrix}$$

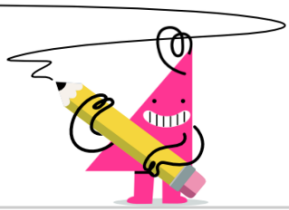
A $\begin{pmatrix} 1 \\ 1 \\ -1 \end{pmatrix}$

B $\begin{pmatrix} 0 \\ -9 \\ 9 \end{pmatrix}$

C $\begin{pmatrix} -3 \\ 3 \\ 3 \end{pmatrix}$

D $\begin{pmatrix} -3 \\ -6 \\ 12 \end{pmatrix}$

Name



Planes in 3D Space - Intro

5 Write the parametric equations of the plane.

$$\vec{r} = \begin{pmatrix} 2 \\ 1 \\ 4 \end{pmatrix} + s \begin{pmatrix} 2 \\ -3 \\ 3 \end{pmatrix} + t \begin{pmatrix} 4 \\ 2 \\ 3 \end{pmatrix}$$

A

$$\begin{aligned} x &= 2 + 2s + 4t \\ y &= 1 + -3s + 2 \\ z &= 4 + 3s + 3t \end{aligned}$$

B

$$\begin{aligned} x &= 2 + 2s + 4t \\ y &= -3 + 1s + 2 \\ z &= 3 + 4s + 3t \end{aligned}$$

C

$$\begin{aligned} x &= 2 + 4s + 2t \\ y &= 1 + 2s + -3 \\ z &= 4 + 3s + 3t \end{aligned}$$

6 Write the vector equation of the plane through the point parallel to both vectors.

$$\text{Point } (-4,\ 1,\ 2) \quad \vec{u} = \begin{pmatrix} -4 \\ 0 \\ 3 \end{pmatrix} \quad \vec{v} = \begin{pmatrix} 4 \\ -1 \\ -3 \end{pmatrix}$$

A

$$\vec{r} = \begin{pmatrix} -4 \\ 0 \\ 3 \end{pmatrix} + s \begin{pmatrix} -4 \\ 1 \\ 2 \end{pmatrix} + t \begin{pmatrix} 4 \\ -1 \\ -3 \end{pmatrix}$$

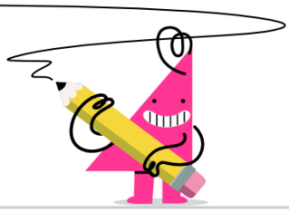
B

$$\vec{r} = \begin{pmatrix} -4 \\ 1 \\ 2 \end{pmatrix} + s \begin{pmatrix} 0 \\ -1 \\ 0 \end{pmatrix} + t \begin{pmatrix} 4 \\ -1 \\ -3 \end{pmatrix}$$

C

$$\vec{r} = \begin{pmatrix} -4 \\ 1 \\ 2 \end{pmatrix} + s \begin{pmatrix} -4 \\ 0 \\ 3 \end{pmatrix} + t \begin{pmatrix} 4 \\ -1 \\ -3 \end{pmatrix}$$

Name



Planes in 3D Space - Intro

7 Find the scalar equation of the plane through the three points.

A $(1,\ 2,\ -2)$ B $(0,\ 2,\ -2)$ C $(-1,\ 0,\ 0)$

A	$x+z=0$
B	$+y+z=0$
C	$+y+z=4$
D	$-y-z=0$

8 Find the scalar equation of the plane through the point parallel to both vectors.

Point $(1,\ 3,\ 0)$ $\vec{u}=\begin{pmatrix}-2\\4\\0\end{pmatrix}$ $\vec{v}=\begin{pmatrix}-1\\4\\3\end{pmatrix}$

A

$$6x+3y-2z=15$$

B

$$-6x-3y+2z=15$$

C

$$6x+3y-2z=18$$

D

$$-2x+6y+3z=15$$

9 Write the plane in point-normal form.

Point $(2,\ 0,\ 1)$ Normal $\begin{pmatrix}-1\\-1\\-4\end{pmatrix}$

A	$-(x+2)-(y)-4(z+1)=0$
B	$(x-2)+(y)+4(z-1)=0$
C	$-(x-2)-(y)-4(z-1)=0$

10 Find the scalar equation of the plane.

Point $(-4,\ 2,\ -2)$ Normal $\begin{pmatrix}4\\-3\\-1\end{pmatrix}$

A

$$4x-3y-z=-18$$

B

$$4x-3y-z=-20$$

C

$$-x+4y-3z=-20$$

D

$$-4x+3y+z=-20$$

11 Does the given point lie on the plane?

$-4x-3z=-6$ Point $(1,\ -3,\ 0)$

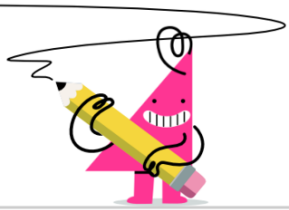
A	B
No	Yes

12 Find the y-intercept of the plane.

$$x+3y+2z=6$$

A	$(0,\ 2,\ 0)$
B	$(0,\ 3,\ 0)$
C	$(0,\ 4,\ 0)$
D	$(0,\ -2,\ 0)$

Name



Planes in 3D Space - Intro

13 Find the vector equation of the normal line to the plane through the given point.

$$+y-z=-6 \quad \text{Point on plane } (2,\ -2,\ 4)$$

A

$$\vec{r}=\begin{pmatrix}2\\-2\\4\end{pmatrix}+t\begin{pmatrix}0\\1\\-1\end{pmatrix}$$

B

$$\vec{r}=\begin{pmatrix}0\\1\\-1\end{pmatrix}+t\begin{pmatrix}2\\-2\\4\end{pmatrix}$$

C

$$\vec{r}=\begin{pmatrix}2\\-2\\4\end{pmatrix}+t\begin{pmatrix}2\\-2\\4\end{pmatrix}$$

D

$$\vec{r}=\begin{pmatrix}2\\-2\\4\end{pmatrix}+t\begin{pmatrix}1\\0\\0\end{pmatrix}$$

14 Find a vector equation of the plane through the three points.

$$\text{A } (4,\ -3,\ -3) \quad \text{B } (-4,\ 3,\ -1) \quad \text{C } (-1,\ 1,\ 4)$$

A

$$\vec{r}=\begin{pmatrix}4\\-3\\-3\end{pmatrix}+s\begin{pmatrix}-8\\6\\2\end{pmatrix}+t\begin{pmatrix}-5\\4\\7\end{pmatrix}$$

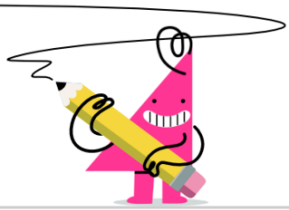
B

$$\vec{r}=\begin{pmatrix}4\\-3\\-3\end{pmatrix}+s\begin{pmatrix}-4\\3\\-1\end{pmatrix}+t\begin{pmatrix}-1\\1\\4\end{pmatrix}$$

C

$$\vec{r}=\begin{pmatrix}-8\\6\\2\end{pmatrix}+s\begin{pmatrix}4\\-3\\-3\end{pmatrix}+t\begin{pmatrix}-5\\4\\7\end{pmatrix}$$

Name



Planes in 3D Space - Intro

15 Write a vector equation of the plane through the point parallel to both vectors.

$$\text{Point } (4,\ -1,\ 4) \quad \vec{u} = \begin{pmatrix} -1 \\ 0 \\ 1 \end{pmatrix} \quad \vec{v} = \begin{pmatrix} 3 \\ 4 \\ -2 \end{pmatrix}$$

A

$$\vec{r} = \begin{pmatrix} 4 \\ -1 \\ 4 \end{pmatrix} + s \begin{pmatrix} -1 \\ 0 \\ 1 \end{pmatrix} + t \begin{pmatrix} 3 \\ 4 \\ -2 \end{pmatrix}$$

B

$$\vec{r} = \begin{pmatrix} -1 \\ 0 \\ 1 \end{pmatrix} + s \begin{pmatrix} 4 \\ -1 \\ 4 \end{pmatrix} + t \begin{pmatrix} 3 \\ 4 \\ -2 \end{pmatrix}$$

C

$$\vec{r} = \begin{pmatrix} 4 \\ -1 \\ 4 \end{pmatrix} + s \begin{pmatrix} 2 \\ 4 \\ -1 \end{pmatrix} + t \begin{pmatrix} -4 \\ -4 \\ 3 \end{pmatrix}$$

16 Write a vector equation of the plane.

$$\text{Point } (-1,\ -2,\ -3) \quad \text{Normal } \begin{pmatrix} 3 \\ -3 \\ -3 \end{pmatrix}$$

A

$$\vec{r} = \begin{pmatrix} -1 \\ -2 \\ -3 \end{pmatrix} + s \begin{pmatrix} 3 \\ -3 \\ -3 \end{pmatrix} + t \begin{pmatrix} 3 \\ 0 \\ 3 \end{pmatrix}$$

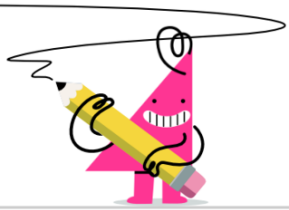
B

$$\vec{r} = \begin{pmatrix} -1 \\ -2 \\ -3 \end{pmatrix} + s \begin{pmatrix} 3 \\ 0 \\ 3 \end{pmatrix} + t \begin{pmatrix} -9 \\ -18 \\ 9 \end{pmatrix}$$

C

$$\vec{r} = \begin{pmatrix} 3 \\ -3 \\ -3 \end{pmatrix} + s \begin{pmatrix} 3 \\ 0 \\ 3 \end{pmatrix} + t \begin{pmatrix} -9 \\ -18 \\ 9 \end{pmatrix}$$

Name



Planes in 3D Space - Intro

17 Does the given point lie on the plane?

$$\vec{r} = \begin{pmatrix} 3 \\ 4 \\ -2 \end{pmatrix} + s\begin{pmatrix} 1 \\ 0 \\ 4 \end{pmatrix} + t\begin{pmatrix} -12 \\ -17 \\ 3 \end{pmatrix} \quad \text{Point } (4,\ -4,\ 25)$$

A	B
No	Yes

18 Find the z-intercept of the plane.

$$\vec{r} = \begin{pmatrix} -3 \\ 3 \\ 6 \end{pmatrix} + s\begin{pmatrix} 0 \\ 3 \\ -4 \end{pmatrix} + t\begin{pmatrix} -25 \\ 8 \\ 6 \end{pmatrix}$$

A	$(0,\ 0,\ -8)$	B	$(0,\ 0,\ 3)$
C	$(0,\ 0,\ 9)$	D	$(0,\ 0,\ 8)$
E	$(0,\ 0,\ 10)$		

19 Find the vector equation of the normal line to the plane through the given point.

$$\vec{r} = \begin{pmatrix} 1 \\ 0 \\ -3 \end{pmatrix} + s\begin{pmatrix} 0 \\ 3 \\ 0 \end{pmatrix} + t\begin{pmatrix} -9 \\ 0 \\ 9 \end{pmatrix} \quad \text{Point on plane } (-2,\ 3,\ 0)$$

A

$$\vec{r} = \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix} + t\begin{pmatrix} -2 \\ 3 \\ 0 \end{pmatrix}$$

B

$$\vec{r} = \begin{pmatrix} -2 \\ 3 \\ 0 \end{pmatrix} + t\begin{pmatrix} -2 \\ 3 \\ 0 \end{pmatrix}$$

C

$$\vec{r} = \begin{pmatrix} -2 \\ 3 \\ 0 \end{pmatrix} + t\begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$$

D

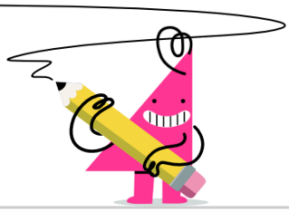
$$\vec{r} = \begin{pmatrix} -2 \\ 3 \\ 0 \end{pmatrix} + t\begin{pmatrix} -1 \\ 0 \\ 1 \end{pmatrix}$$

20 The line through the external point perpendicular to the plane meets the plane. Find that point.

$$-2x + y + 4z = 4 \quad \text{External point } (-9,\ 1,\ 12)$$

A	$(-9,\ 1,\ 12)$
B	$(3,\ -5,\ -12)$
C	$(-3,\ -2,\ 0)$
D	$(-5,\ -1,\ 4)$

Name



Planes in 3D Space - Intro

21 Find the vector equation of the normal line to the plane that passes through the external point.

$$-x-y+3z=6 \quad \text{External point } (-4,\ 3,\ 3)$$

A

$$\vec{r}=\begin{pmatrix}-4\\3\\3\end{pmatrix}+t\begin{pmatrix}-1\\-1\\3\end{pmatrix}$$

B

$$\vec{r}=\begin{pmatrix}-4\\3\\3\end{pmatrix}+t\begin{pmatrix}-4\\3\\3\end{pmatrix}$$

C

$$\vec{r}=\begin{pmatrix}-4\\3\\3\end{pmatrix}+t\begin{pmatrix}-1\\1\\0\end{pmatrix}$$

D

$$\vec{r}=\begin{pmatrix}-4\\3\\3\end{pmatrix}+t\begin{pmatrix}1\\-1\\3\end{pmatrix}$$

E

$$\vec{r}=\begin{pmatrix}-1\\-1\\3\end{pmatrix}+t\begin{pmatrix}-4\\3\\3\end{pmatrix}$$

22 Find the shortest distance from the external point to the plane (to 2 decimal places).

$3x-2y-2z=-6 \quad \text{External point } (12,\ -5,\ -8)$

A	B	C
16.49	4.00	16.98

D	E
17.37	14.84

23 Find the scalar equation of the plane through the point, perpendicular to the given line.

$\text{Point } (4,\ -1,\ 1) \quad \text{Perpendicular line } \vec{r}=\begin{pmatrix}0\\-4\\0\end{pmatrix}+t\begin{pmatrix}-2\\3\\1\end{pmatrix}$

A

$$x-2y+3z=-10$$

B

$$-2x+3y+z=-10$$

C

$$2x-3y-z=-10$$

D

$$-2x+3y+z=-9$$

24 Find the scalar equation of the plane containing both lines.

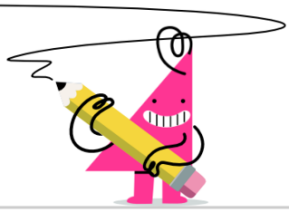
A $20x-6y+9z=45$

B $-20x+6y-9z=45$

C $-9x-20y+6z=45$

D $-20x+6y-9z=46$

Name



Planes in 3D Space - Intro

25 Find the scalar equation of the plane containing the point and the line.

Point $(-8,\ -2,\ -3)$ Line $\vec{r} = \begin{pmatrix} -4 \\ 1 \\ -3 \end{pmatrix} + t \begin{pmatrix} 3 \\ -4 \\ 0 \end{pmatrix}$

A $-x = 75$

B $-z = 76$

C $+z = 75$

D $-z = 75$

26 Find the scalar equation of the plane through the point, parallel to the given plane.

Point $(1,\ -3,\ -2)$ Parallel plane $-x + 4y + 2z = -5$

A $x - 4y - 2z = -17$

B $2x - y + 4z = -17$

C $-x + 4y + 2z = -17$

D $-x + 4y + 2z = -13$

27 Select the matrix that highlights the products for the indicated component of the cross product. Green marks the positive product; red marks the negative product.

28 Select the matrix that highlights the products for the indicated component of the cross product. Green marks the positive product; red marks the negative product.

29 Find the indicated component of the cross product.

A $x = 1 \cdot (-1) + 1 \cdot (-3) = -4$

B $x = 1 \cdot (-1) - 1 \cdot (-3) = 2$

C $x = 1 \cdot (-4) - (-3) \cdot (-1) = -7$

D $x = 1 \cdot (-3) - 1 \cdot (-1) = -2$

30 Find the indicated component of the cross product.

A $y = (-1) \cdot (-1) - (-1) \cdot 3 = 4$

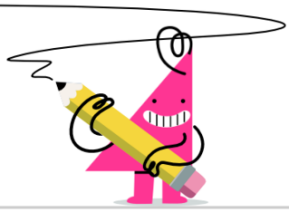
B $y = (-1) \cdot 3 + (-1) \cdot (-1) = -2$

C $y = (-1) \cdot 3 - (-1) \cdot (-1) = -4$

D $y = (-1) \cdot 3 - 0 \cdot 3 = -3$

31 Find the indicated component of the cross product.

Name



Planes in 3D Space - Intro

32 Find the cross product of the two vectors.

$$\vec{u} \times \vec{v} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 0 & 3 \\ 1 & -4 & 0 \end{vmatrix}$$

A $\vec{u} \times \vec{v} = [12,\ 3,\ 12]$

B $\vec{u} \times \vec{v} = [3,\ 12,\ -12]$

C $\vec{u} \times \vec{v} = [-12,\ -3,\ 12]$

D $\vec{u} \times \vec{v} = [12,\ 3,\ -12]$

33 Find the cross product of the two vectors.

$\vec{u} = [4,\ 3,\ -4] \quad \vec{v} = [0,\ -3,\ 0]$

A $\vec{u} \times \vec{v} = [-12,\ 0,\ 12]$

B $\vec{u} \times \vec{v} = [12,\ 0,\ 12]$

C $\vec{u} \times \vec{v} = [-12,\ 0,\ -12]$

D $\vec{u} \times \vec{v} = [0,\ -12,\ -12]$

34 Given the normal vectors of two planes, are the planes parallel or coincident?

$$\vec{n_1} = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} \quad \vec{n_2} = \begin{pmatrix} 0 \\ 2 \\ 0 \end{pmatrix}$$

A Neither

B Parallel or coincident

35 What is the relationship between the two planes?

A Coincident

B Perpendicular

C Neither

D Parallel

36 Are the two planes perpendicular?

A	B
No	Yes

37 Find the acute angle between the two planes.

38 Find the acute angle between the two planes.

$$\vec{n_1} = \begin{pmatrix} 3 \\ 0 \\ 1 \end{pmatrix} \quad \vec{n_2} = \begin{pmatrix} -1 \\ -4 \\ 1 \end{pmatrix}$$