12.3

3

$\langle 0,1,1\rangle \cdot \langle -7,41,-39\rangle$
$= 0 + 41 + -39$
$= \boxed{2}$

13

$\vec{a} = \langle 1,1,1\rangle$
$\vec{b} = \langle 1,-2,-2\rangle$
$\vec{a} \cdot \vec{b} = ||\vec{a}||||\vec{b}|| \cos(\theta)$

$\langle 1,1,1\rangle \cdot \langle 1,-2,-2\rangle$
$= 1 - 2 - 2$
$= -3$

$||\vec{a}|| = \sqrt{3}$
$||\vec{b}|| = 3$

$\cos\theta = \frac{-\sqrt{3}}{3}$
$\theta = 2.19$

$\theta > \pi/2$
$\therefore \theta$ is obtuse $\square$

19

$\vec{a} = \langle 0,3,1\rangle$
$\vec{b} = \langle 4,0,0\rangle$
$\vec{a} \cdot \vec{b} = ||\vec{a}||||\vec{b}|| \cos(\theta)$

$\langle 0,3,1\rangle \cdot \langle 4,0,0\rangle$
$= 0$

$||\vec{a}|| = \sqrt{10}$
$||\vec{b}|| = 2$

$\cos\theta = 0$

27

$\vec{a} = \langle 0,1,1\rangle$
$\vec{b} = \langle 1,-1,0\rangle$
$\vec{a} \cdot \vec{b} = ||\vec{a}||||\vec{b}|| \cos(\theta)$

$\langle 0,1,1\rangle \cdot \langle 1,-1,0\rangle$
$= -1$

$\|\vec{a}\| = \sqrt{2}$
$\|\vec{b}\| = \sqrt{2}$

$\cos\theta = \frac{-1}{2}$
$\theta = \boxed{2.09}$

43

$2\vec{u} \cdot (3\vec{u} - \vec{v})$
$= 6(\vec{u} \cdot \vec{u}) - 2(\vec{u} \cdot \vec{v})$
$= 6\|\vec{u}\|^2 - 2(2)$
$= 6 - 4$
$= \boxed{2}$

12.4

9

$\vec{a} = \langle 1, 2, 1 \rangle$
$\vec{b} = \langle 3, 1, 1 \rangle$

$\langle 1, 2, 1 \rangle \times \langle 3, 1, 1 \rangle$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & 1 \\ 3 & 1 & 1 \end{vmatrix}$$

$= \langle 1, 2, -5 \rangle_{\square}$

17

$(\hat{i} - 3\hat{j} + 2\hat{k}) \times (\hat{j} - \hat{k})$
$= \langle 1, -3, 2 \rangle \times \langle 0, 1, -1 \rangle$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -3 & 2 \\ 0 & 1 & -1 \end{vmatrix}$$

$= \langle 1, 1, 1 \rangle$

$(\hat{i} - 3\hat{j} + 2\hat{k}) \times (\hat{j} - \hat{k})$
$= \hat{k} + \hat{j} + 3\hat{i} - 2\hat{i}$
$= \hat{i} + \hat{j} + \hat{k}$
$= \langle 1, 1, 1 \rangle$

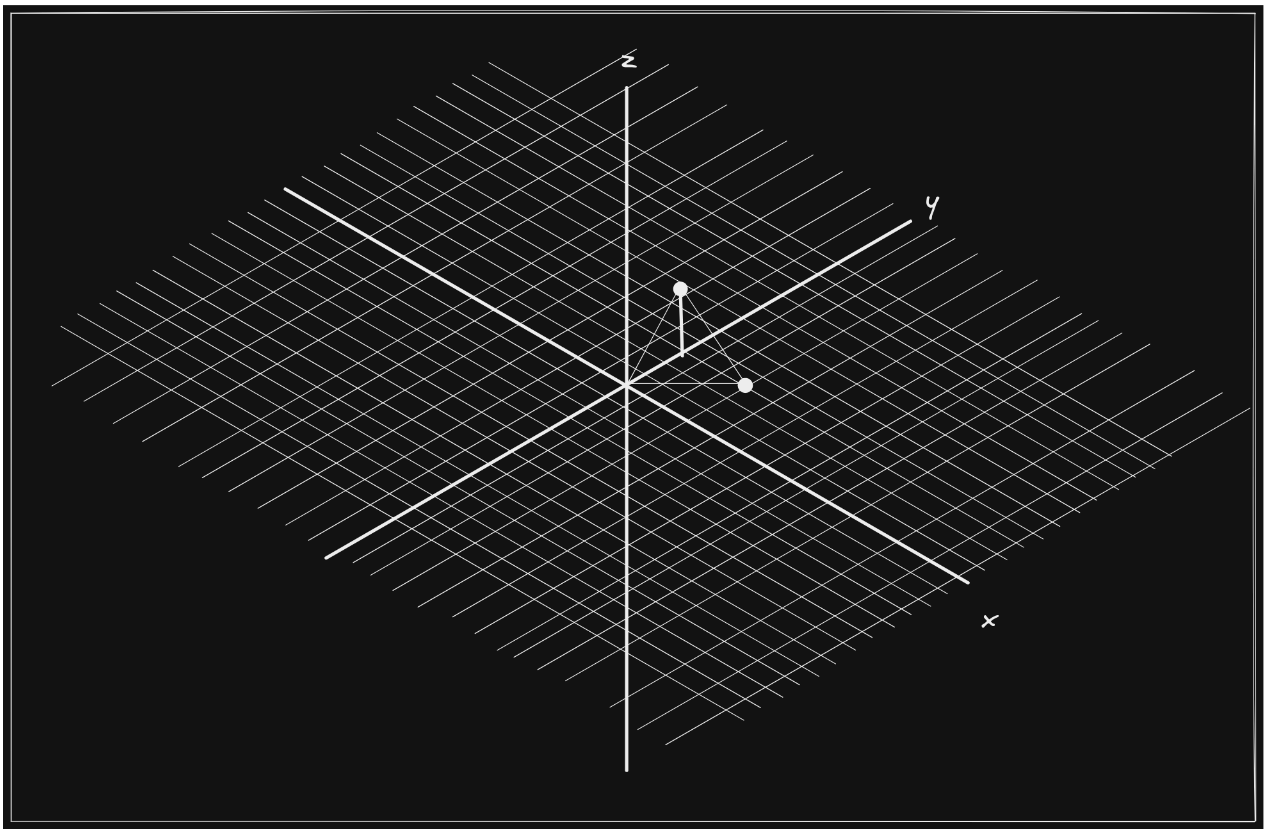
23

$(\vec{u} - 2\vec{v}) \times (\vec{u} + 2\vec{v})$
$= 2(\vec{u} \times \vec{v}) - 2(\vec{v} \times \vec{u})$
$= 4(\vec{u} \times \vec{v})$
$= 4\langle 1, 1, 0 \rangle$
$= \langle 4, 4, 0 \rangle_{\square}$

41

$\vec{v} = \langle 1, 3, 1 \rangle$
$\vec{w} = \langle -4, 2, 6 \rangle$
$\|\vec{v} \times \vec{w}\| = \| \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 3 & 1 \\ -4 & 2 & 6 \end{vmatrix} \|$
$= \|\langle 16, -10, 14 \rangle\|$
$= \sqrt{552} \square$

47



$\vec{P} = \langle 3, 3, 0 \rangle$
$\vec{Q} = \langle 0, 3, 3 \rangle$
$\frac{\|\vec{P} \times \vec{Q}\|}{2} = \| \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 3 & 0 \\ 0 & 3 & 3 \end{vmatrix} \| / 2$
$= \|\langle 9, -9, 9 \rangle\| / 2$
$= \sqrt{243} / 2$
$= 7.79 \square$

12.5

17

$(0, 0, 0)$
$4x - 9y + z = 3 + C$

$0 = 3 + C$
$C = -3$

$4x - 9y + z = 0$ □

21

$P = (2, -1, 4)$
$Q = (1, 1, 1)$
$R = (3, 1, -2)$

$ax + by + cz = C$

$$\begin{cases} 2a - b + 4c = C \\ a + b + c = C \\ 3a + b - 2c = C \end{cases}$$

Let c=1

$$= \begin{cases} a = C/2 + b/2 - 2 \\ b = C/3 + 2/3 \\ C = 19/4 \end{cases}$$

$$= \begin{cases} a = 3/2 \\ b = 9/4 \\ c = 1 \\ C = 19/4 \end{cases}$$

$3x/2 + 9y/4 + z = 19/4$
$6x + 9y + 4z = 19$ □

27a

$\vec{r_1}(t_1) = \langle t_1, 2t_1 - 1, t_1 - 3 \rangle$
$\vec{r_2}(t_2) = \langle 4, 2t_2 - 1, -1 \rangle$

$$\begin{cases} t_1 = 4 \\ 2t_1 - 1 = 2t_2 - 1 \\ t_1 - 3 = -1 \end{cases}$$

$$\begin{cases} t_1 = 4 \\ t_1 = t_2 \\ t_1 = 2 \end{cases}$$

Since there is no pair of t_1 and t_2 such that $\vec{r_1}(t_1) = \vec{r_2}(t_2)$, the lines will never equal at any time and therefore do not intersect.

27b

$\vec{r_1}(t_1) = \langle 3t_1, 2t_1 + 1, t_1 - 5 \rangle$
$\vec{r_2}(t_2) = \langle 4t_2, 4t_2 - 3, -1 \rangle$

$$\begin{cases} 3t_1 = 4t_2 \\ 2t_1 + 1 = 4t_2 - 3 \\ t_1 - 5 = -1 \end{cases}$$

$$\begin{cases} t_1 = 4t_2/3 \\ t_1 = 2t_2 - 2 \\ t_1 = 4 \end{cases}$$

$$\begin{cases} t_1 = 4 \\ t_2 = 3 \\ t_1 = 4 \end{cases}$$
$\vec{P} = \langle 12, 9, -1 \rangle$

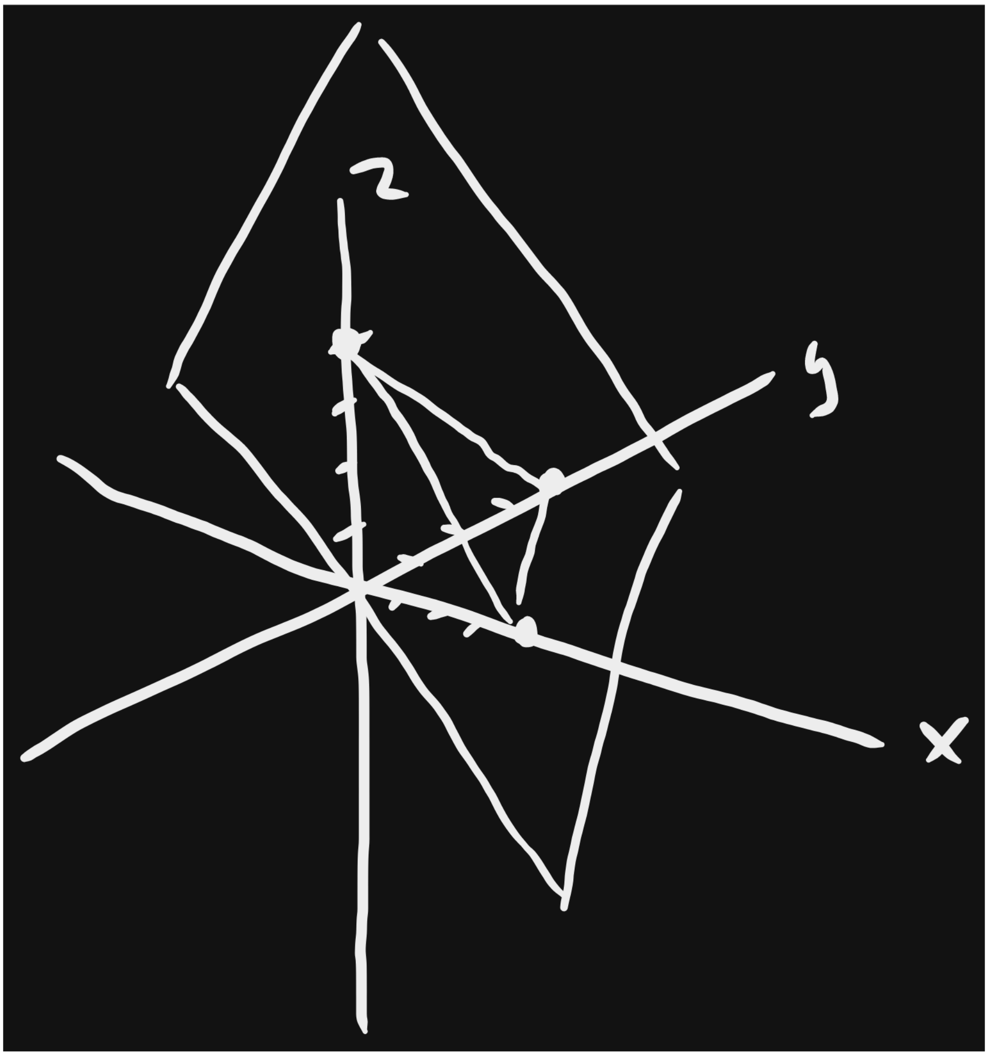
Since the vectors are equal when $t_1 = 4$ and $t_2 = 3$, lines intersect.

$\vec{r_1}(t_1) = t_1\langle 3, 2, 1 \rangle + \langle 0, 1, -5 \rangle$
$\vec{r_2}(t_2) = t_2\langle 4, 4, 0 \rangle + \langle 0, -3, -1 \rangle$

$\vec{N} = \langle 3, 2, 1 \rangle \times \langle 4, 4, 0 \rangle$
$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 2 & 1 \\ 4 & 4 & 0 \end{vmatrix}$
$= \langle -4, 4, 4 \rangle$

$-4(x - 12) + 4(y - 9) + 4(z + 1) = 0$
$-4x + 4y + 4z = -16 \square$

33



57

$\vec{a} = \langle 1, 0, 1 \rangle$
$\vec{b} = \langle -1, 1, 1 \rangle$

$$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 0 & 1 \\ -1 & 1 & 1 \end{vmatrix}$$

$= -1 - 2 + 1$

$= -2$

$\vec{a} \times \vec{b} = \|\vec{a}\| \|\vec{b}\| \cos(\theta)$

$cos\theta = -2/(\sqrt{2} * \sqrt{3})$

$\theta = 2.26 \square$