12.3

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

$$egin{aligned} ec{a} &= \langle 1,1,1
angle \ ec{b} &= \langle 1,-2,-2
angle \ ec{a} \cdot ec{b} &= \|ec{a}\| \|ec{b}\| \cos(heta) \end{aligned}$$

$$\begin{split} \langle 1,1,1\rangle \cdot \langle 1,-2,-2\rangle \\ &= 1-2-2 \\ &= -3 \end{split}$$

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

$$\cos heta = rac{-\sqrt{3}}{3} \ heta = 2.19$$

$$heta>\pi/2$$

 $\therefore \theta$ is obtuse \Box

$$egin{aligned} ec{a} &= \langle 0, 3, 1
angle \ ec{b} &= \langle 4, 0, 0
angle \ ec{a} \cdot ec{b} &= \|ec{a}\| \|ec{b}\| \cos(heta) \end{aligned}$$

$$\begin{aligned} \langle 0,3,1\rangle \cdot \langle 4,0,0\rangle \\ &= 0 \end{aligned}$$

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

$$\cos \theta = 0$$

$$egin{aligned} ec{a} &= \langle 0, 1, 1
angle \ ec{b} &= \langle 1, -1, 0
angle \ ec{a} \cdot ec{b} &= \|ec{a}\| \|ec{b}\| \cos(heta) \end{aligned}$$

$$\begin{aligned} \langle 0,1,1\rangle \cdot \langle 1,-1,0\rangle \\ = -1 \end{aligned}$$

$$\begin{aligned} \|\vec{a}\| &= \sqrt{2} \\ \|\vec{b}\| &= \sqrt{2} \end{aligned}$$
$$\cos \theta &= \frac{-1}{2}$$
$$\theta &= \boxed{2.09}$$

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

12.4

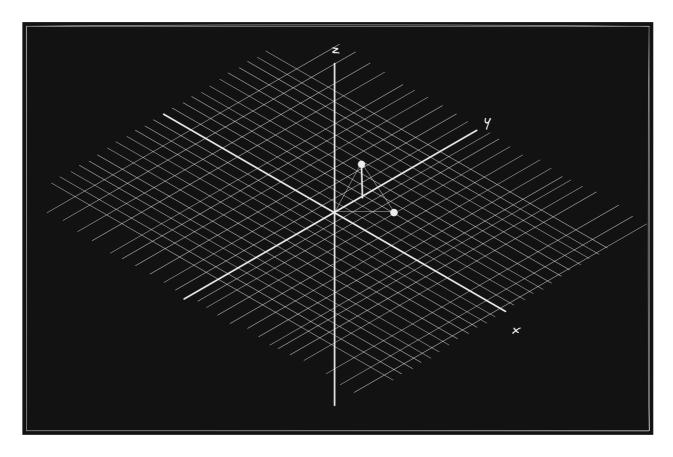
$$egin{aligned} ec{a} &= \langle 1,2,1
angle \ ec{b} &= \langle 3,1,1
angle \ &\langle 1,2,1
angle imes \langle 3,1,1
angle \ &\langle 1,2,1
angle imes \langle 3,1,1
angle \ &| \hat{i} \quad \hat{j} \quad \hat{k} \ 1 \quad 2 \quad 1 \ 3 \quad 1 \quad 1 \ \end{vmatrix} \ = \langle 1,2,-5
angle_{\square} \end{aligned}$$

$$egin{aligned} (\hat{i}-3\hat{j}+2\hat{k}) imes (\hat{j}-\hat{k}) \ &= \langle 1,-3,2
angle imes \langle 0,1,-1
angle \ &|\hat{i} \quad \hat{j} \quad \hat{k} \ &|1 \quad -3 \quad 2 \ &|0 \quad 1 \quad -1 \ &|= \langle 1,1,1
angle \end{aligned}$$

$$egin{aligned} (\hat{i} - 3\hat{j} + 2\hat{k}) imes (\hat{j} - \hat{k}) \ &= \hat{k} + \hat{j} + 3\hat{i} - 2\hat{i} \ &= \hat{i} + \hat{j} + \hat{k} \ &= \langle 1, 1, 1
angle \end{aligned}$$

$$egin{aligned} (\vec{u}-2\vec{v}) imes (\vec{u}+2\vec{v}) \ &= 2(\vec{u} imes \vec{v}) - 2(\vec{v} imes \vec{u}) \ &= 4(\vec{u} imes \vec{v}) \ &= 4\langle 1,1,0
angle \ &= \langle 4,4,0
angle_{\square} \end{aligned}$$

$$egin{aligned} ec{v} &= \langle 1, 3, 1
angle \ ec{w} &= \langle -4, 2, 6
angle \ \| ec{v} imes ec{w} \| = \| egin{aligned} \hat{i} & \hat{j} & \hat{k} \ 1 & 3 & 1 \ -4 & 2 & 6 \ \end{bmatrix} \| \ &= \| \langle 16, -10, 14
angle \| \ &= \sqrt{552}_{\square} \end{aligned}$$



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

12.5

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

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

21

$$\begin{split} P &= (2, -1, 4) \\ Q &= (1, 1, 1) \\ R &= (3, 1, -2) \\ ax + by + cz = C \\ \begin{cases} 2a - b + 4c = C \\ a + b + c = C \\ 3a + b - 2c = C \end{cases} \\ \text{Let c=1} \\ &= \begin{cases} a &= C/2 + b/2 - 2 \\ b &= C/3 + 2/3 \\ C &= 19/4 \\ C &= 1 \\ C &= 19/4 \end{cases} \\ = \begin{cases} a &= 3/2 \\ b &= 9/4 \\ c &= 1 \\ C &= 19/4 \end{cases} \end{split}$$

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

 $6x + 9y + 4z = 19$

27a

$$ec{r_1}(t_1) = \langle t_1, 2t_1 - 1, t_1 - 3
angle \ ec{r_2}(t_2) = \langle 4, 2t_2 - 1, -1
angle \ egin{dcases} t_1 = 4 \ 2t_1 - 1 = 2t_2 - 1 \ t_1 - 3 = -1 \ t_1 = 4 \ t_1 = t_2 \ t_1 = 2 \end{cases}$$

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

$$ec{r_1}(t_1) = \langle 3t_1, 2t_1 + 1, t_1 - 5
angle \ ec{r_2}(t_2) = \langle 4t_2, 4t_2 - 3, -1
angle \ \begin{cases} 3t_1 = 4t_2 \ 2t_1 + 1 = 4t_2 - 3 \ t_1 - 5 = -1 \ \begin{cases} t_1 = 4t_2/3 \ t_1 = 2t_2 - 2 \ t_1 = 4 \end{cases}$$

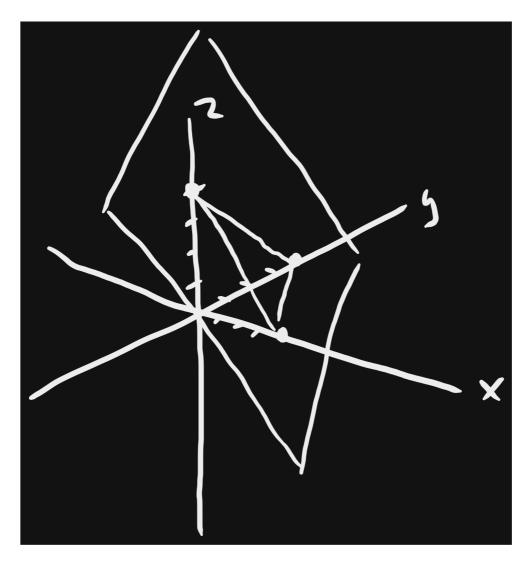
$$egin{cases} t_1 = 4 \ t_2 = 3 \ t_1 = 4 \ ec{P} = \langle 12, 9, -1
angle \end{cases}$$

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

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

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

 $-4x + 4y + 4z = -16_{\square}$



$$ec{a} = \langle 1,0,1
angle \ ec{b} = \langle -1,1,1
angle$$

$$ec{a} imes ec{b} = egin{array}{ccc} \hat{i} & \hat{j} & \hat{k} \ 1 & 0 & 1 \ -1 & 1 & 1 \ \end{bmatrix} \ = -1 - 2 + 1 \ = -2 \ ec{a} imes ec{b} = \|ec{a}\| \|ec{b}\| \cos(heta) \ \cos heta = -2/(\sqrt{2} * \sqrt{3}) \ heta = 2.26_{\square} \ \end{array}$$