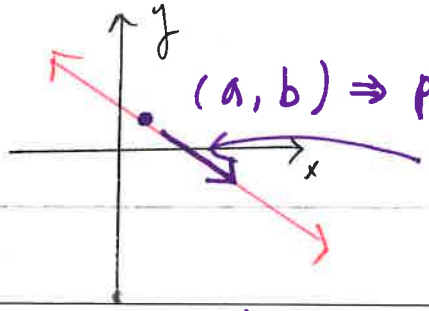
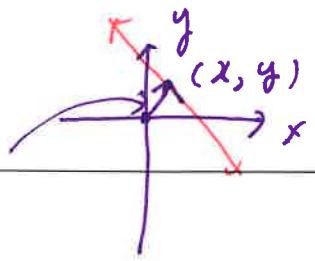
1. **Lines in 2-D.**



$(a, b) \Rightarrow$ position on the line.

slope: Directional vector

$x_1 i + y_1 j$

Cartesian Equation	$y = mx + b$, $Ax + By = C$. $\dfrac{x-a}{x_1} = \dfrac{y-b}{y_1}$ 
Parametric Equation	$x = a + x_1 t$ $y = b + y_1 t$
Vector Equation	$\vec{r} = x i + y j \Rightarrow \vec{r} = \begin{pmatrix} a \\ b \end{pmatrix} + t \begin{pmatrix} x_1 \\ y_1 \end{pmatrix} \Leftrightarrow \vec{r} = (a i + b j) + t(x_1 i + y_1 j)$

position vector

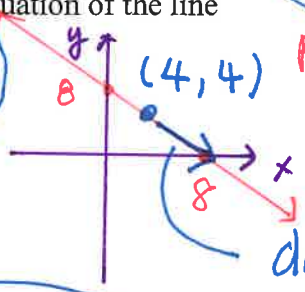
directional vector

Example 1) Given the graph, Write an equation of the line

a. In Cartesian form $\dfrac{x-4}{-1} = \dfrac{y-4}{1}$

b. Parametric form $x = 4 - t$, $y = 4 + t$.

c. Vector form. $\vec{r} = \begin{pmatrix} 4 \\ 4 \end{pmatrix} + t \begin{pmatrix} -1 \\ 1 \end{pmatrix}$



directional vector: $-i + j$ ✓

OR $i - j$ ✓

Example 2) Given $y = 3x - 5$

$(1, -2)$ OR $(0, -5)$

a. Write an equation in the form of $\dfrac{x-a}{x_1} = \dfrac{y-b}{y_1}$.

b. Write an equation in a parametric form. $x = 1 + t$, $y = -2 + 3t$

c. Write an equation in vector form. $\vec{r} = (i - 2j) + t(i + 3j)$

directional vector: $i + 3j$

OR $-i - 3j$

$\dfrac{x-1}{1} = \dfrac{y+2}{3}$

$x = \dfrac{y+5}{3}$

Example 3) A line is passing through $(-2, 5)$ and $(1, 3)$.

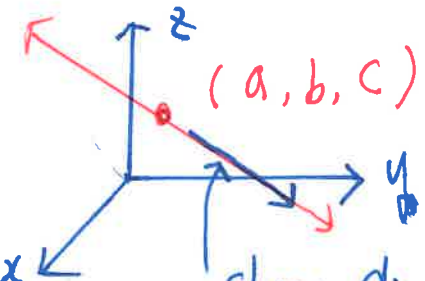
a. Write an equation in the form of $\dfrac{x-a}{x_1} = \dfrac{y-b}{y_1}$. $\dfrac{x+2}{-3} = \dfrac{y-5}{2}$

b. Write an equation in a parametric form. $x = -2 - 3t$, $y = 5 + 2t$.

c. Write an equation in vector form. $\vec{r} = (-2i + 5j) + t(-3i + 2j)$

directional vector $\Rightarrow \begin{pmatrix} -2-1 \\ 5-3 \end{pmatrix} = -3i + 2j$

2. Lines in 3-D.



slope: directional vector $= x_1 i + y_1 j + z_1 k$

Cartesian Equation	$\frac{x-a}{x_1} = \frac{y-b}{y_1} = \frac{z-c}{z_1}$
Parametric Equation	$x = a + x_1 t$ $y = b + y_1 t$ $z = c + z_1 t$
Vector Equation	$\vec{r} = xi + yj + zk \Rightarrow \vec{r} = \begin{pmatrix} a \\ b \\ c \end{pmatrix} + t \begin{pmatrix} x_1 \\ y_1 \\ z_1 \end{pmatrix}$

Directional Vector

position vector

Example 1) Given the line is passing through (2, -1, 4) and (-1, 0, 2).

$\vec{d} = \begin{pmatrix} 2+1 \\ -1-0 \\ 4-2 \end{pmatrix} = 3i - j + 2k$

a. Write an equation in parametric form. $x = 2 + 3t,\ y = -1 - t,\ z = 4 + 2t$

b. Write an equation in vector form. $\vec{r} = \begin{pmatrix} 2 \\ -1 \\ 4 \end{pmatrix} + t \begin{pmatrix} 3 \\ -1 \\ 2 \end{pmatrix}$

c. Write an equation in Cartesian form. $\frac{x-2}{3} = \frac{y+1}{-1} = \frac{z-4}{2}$

Example 2) Given the line is passing through (4, 2, 5) with directional vector $i - j + 2k$

a. Write an equation in parametric form. $x = 4 + t,\ y = 2 - t,\ z = 5 + 2t$

b. Write an equation in vector form. $\vec{r} = (4i + 2j + 5k) + t(i - j + 2k)$

c. Write an equation in Cartesian form. $\frac{x-4}{1} = \frac{y-2}{-1} = \frac{z-5}{2}$

Example 3) Given the line $\frac{2-x}{4} = \frac{y+1}{2} = \frac{4-z}{6} \Rightarrow \frac{x-2}{-4} = \frac{y+1}{2} = \frac{z-4}{-6}$

a. Write an equation in parametric form. $x = 2 - 4t,\ y = -1 + 2t,\ z = 4 - 6t$

b. Write an equation in vector form. $\vec{r} = (2i - j + 4k) + t(-4i + 2j - 6k)$