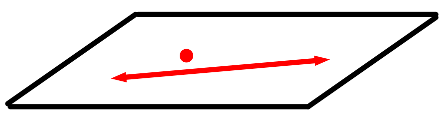
6.4 Vector and Parametric Equations of a Plane

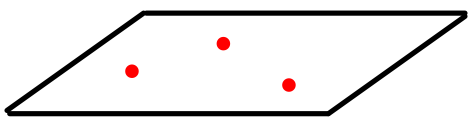
Plane: a flat surface that extends infinitely far in all directions

Planes can be determined/described by:

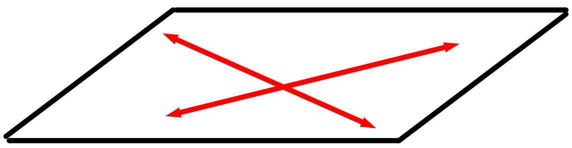
1. a line and a point not on the line



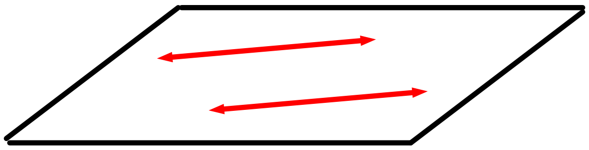
2. 3 noncollinear points



3. two intersecting lines

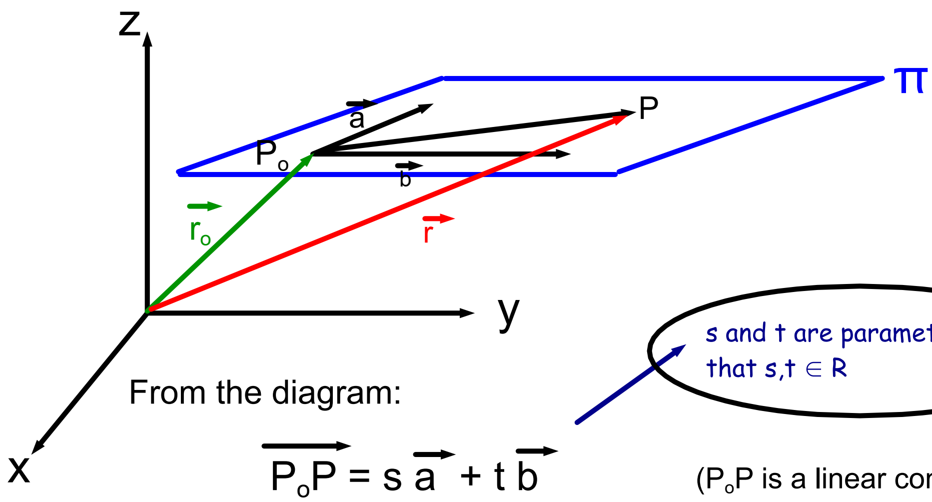


4. Two parallel and non-coincident lines



Recall: Given 2 non-zero/noncollinear vectors $\vec{a}$ and $\vec{b}$ on a plane......the vectors span the plane....ie . every vector in the plane can be written as a linear combination of $\vec{a}$ and $\vec{b}$.

Given two non-collinear vectors, a and b, and the point P_o: a plane "π" is defined....



s and t are parameters such that s,t ∈ R

From the diagram:

$\overrightarrow{P_oP} = s\,\vec{a} + t\,\vec{b}$ (P_oP is a linear combination of a and b)

and $\vec{r} = \vec{r_o} + \overrightarrow{P_oP}$ (triangle law of addition)

$\therefore \vec{r} = \vec{r_o} + s\vec{a} + t\vec{b}$ (Vector Equation of a Plane)

OR

$(x,y,z) = (x_o,y_o,z_o) + s(a_1,a_2,a_3) + t(b_1,b_2,b_3)$ (Vector Equation of a Plane in Component Form)

OR

$$x = x_o + sa_1 + tb_1$$
$$y = y_o + sa_2 + tb_2$$
$$z = z_o + sa_3 + tb_3$$

(Parametric Equations of a Plane)

****need a point and TWO vectors to define a plane****

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Ex. 1

a) Determine the vector and parametric equation of the plane containing the points A(-1,2,3), B(5,2,-3) and C(0,1,-1)

b) Do the points P(2,5,9) and Q(2,5,7) lie on the plane defined in a)?

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Ex. 2 Determine the vector and parametric equations of the plane containing the point P(2,-3,4) and the line, L: $\vec{r}$ = (3,-1,2) + t(1,1,3), t$\in$R.

Ex. 3 Determine the coordinates of the point where the plane,
$\pi : r = (2,1,3) + s(9,-3,4) + t(1,-3,4)$, $s,t \in R$
crosses the y-axis.

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