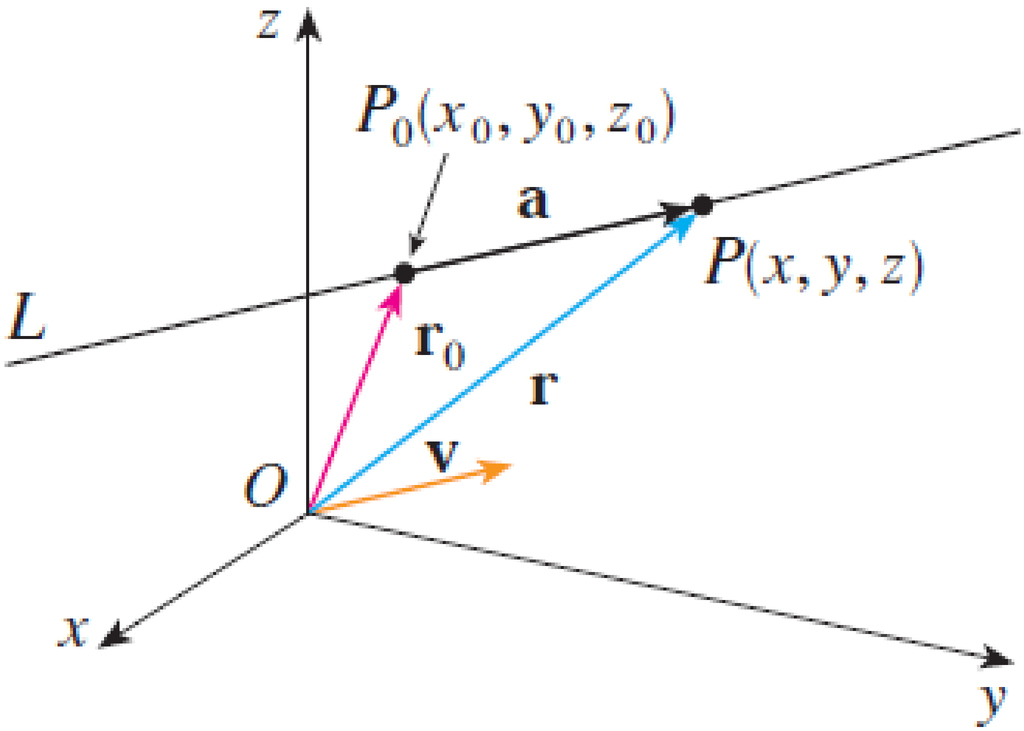
# Visual of a Line in 3D




**Notes:** In the picture,

**v** **=** a vector parallel to the line

$\mathbf{r}_0$ **=** < $x_0$ , $y_0$, $z_0$ >

= a vector that points from the origin to some particular point ($x_0$,$y_0$,$z_0$) on the line.

Recall, any scale multiple of **v** will be parallel to **v**. So consider a vector **a** that can be written as **a** = t**v** (that is the vector **a** in the picture).

Since **a** is parallel to **v** which is parallel to the line, if we add **a** to $\mathbf{r}_0$**,** then it will give another point on the line.

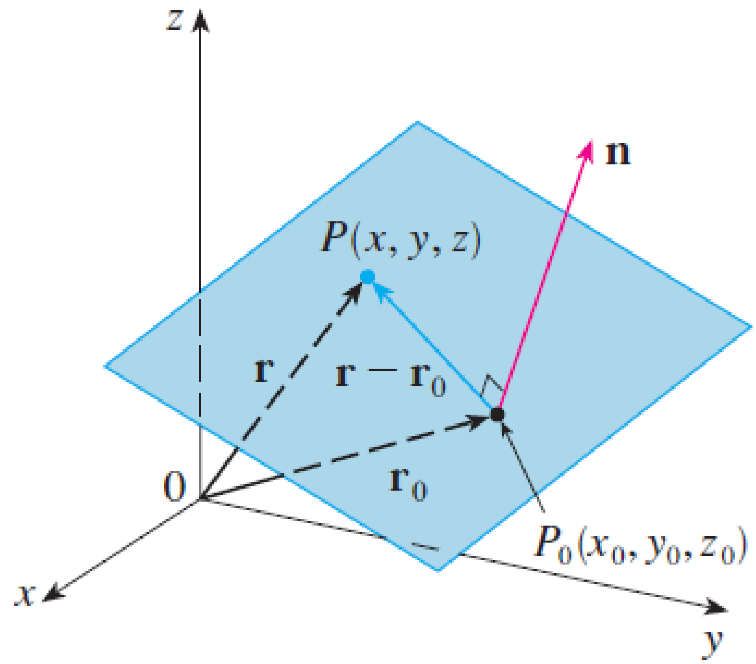
That is, if $\mathbf{r}_0$ + **a =** < x , y, z > = **r ,** then (x,y,z) is also on the line**.**

ALL points on the line can be obtained by doing the same thing with different values of *t.* Thus, all points (x, y, z) on the line satisfy

**r** = < x , y, z > = $\mathbf{r}_0$ + t**v** **(the vector form of the 3D line equation)**

for some scale multiple t.

# Visual of a Plane in 3D




**Notes:** In the picture,

**n** = a vector perpendicular to the plane (a *normal* vector)

$\mathbf{r}_0$ = < $x_0$ , $y_0$, $z_0$ >

= a vector that points from the origin to some particular point ($x_0$,$y_0$,$z_0$) on the plane.

Let (x, y, z) be any other point on the plane.
Consider the vector that points from ($x_0$, $y_0$, $z_0$) to (x, y, z), which is < $x - x_0$, $y - y_0$, $z - z_0$ > (which is denoted by $\mathbf{r} - \mathbf{r_0}$ in the picture)

*Key Observation*: Since **n** is perpendicular to the plane, that means that it must be perpendicular to $\mathbf{r} - \mathbf{r}_0$.
Thus,

$$\mathbf{n} \cdot ( \mathbf{r} - \mathbf{r}_0 ) = 0$$ **(the vector form of the 3D plane equation)**