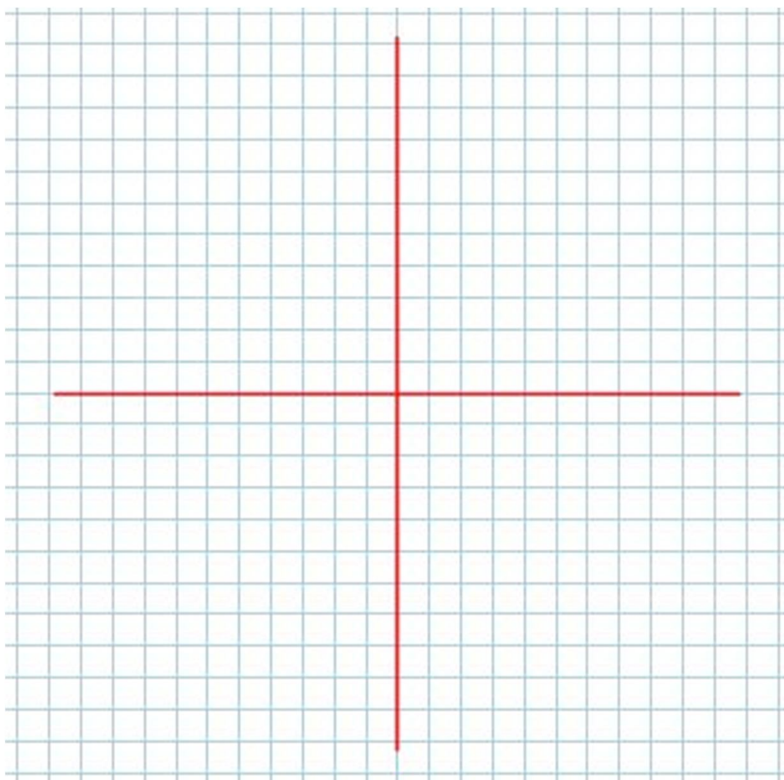
6.5 Vectors in 2D and 3D

In this sections we will (hopefully) begin to see **DEEP** connections between algebra and geometry.

Consider the *x*-*y* plane (also known as the Cartesian plane), with the point $P(3,2)$



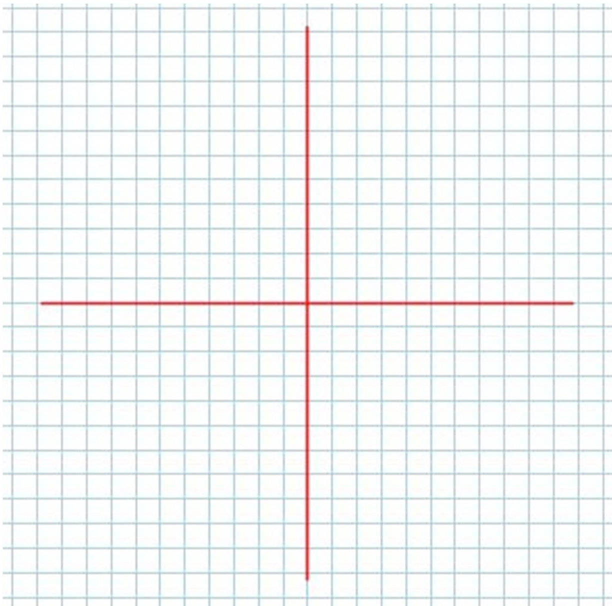
Note: If we draw a vector from $O(0,0)$ "pointing to *P*" we create the vector which is said to be in

We write

Note: Be sure to recognize the **context** that you are working in!!

Example 6.5.1

Draw the vector $\vec{a}=(2,-1)$ in standard position.



Note: We call the **coordinates of the point** (*the axis numbers*) the **components** of the vector.

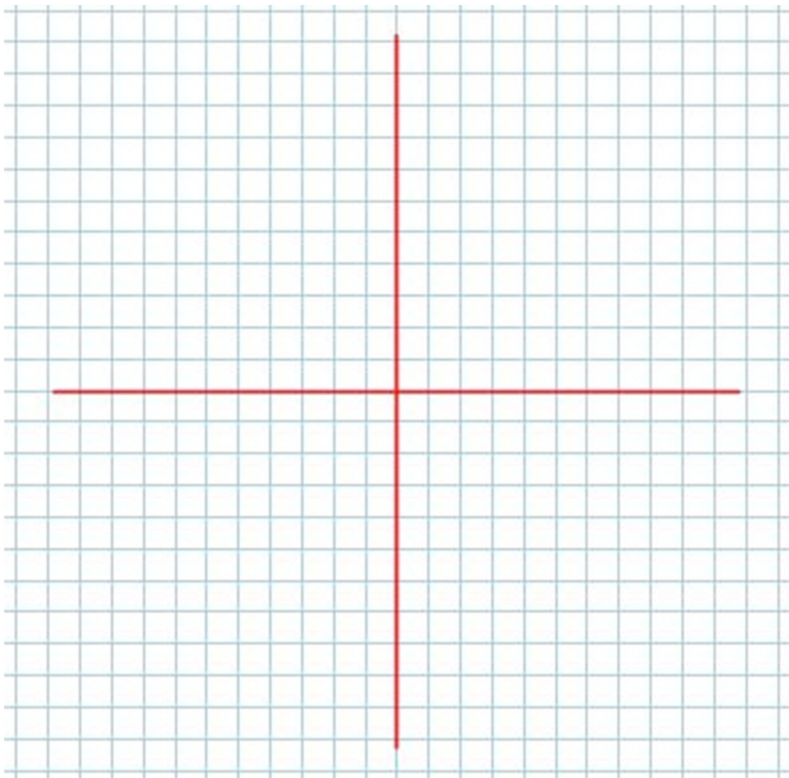
For $\vec{a}=(2,-1)$

Another Note

Vectors in standard position are

The General Position Vector

Consider the position vector $\overrightarrow{OP} = (a, b)$



Note that $\overrightarrow{OP} = (a, b)$ points

Uniquely

at the point $P(a, b)$

We call the collection of **ALL POINTS** in the *x*-*y* plane

We write

Key Note

Moving up to $\mathbb{R}^3$

$\mathbb{R}^2$ is called a two-dimensional **space** because it can be (***fully!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!***) defined using two coordinates. If we add a third coordinate we can discuss (mathematically) a three-dimensional **space** which we call $\mathbb{R}^3$, and which we denote:

$$\mathbb{R}^3 = \left\{ (x, y, z) \middle| x \in \mathbb{R},\ y \in \mathbb{R},\ z \in \mathbb{R} \right\}$$

In $\mathbb{R}^3$ we write the origin as and a general point as

Thus we have the UNIQUE general position vector

Representing Vectors in $\mathbb{R}^3$

Example 6.5.2

Draw the vector $\overrightarrow{OP} = (3, 5, 4)$

Note: The axes form

Example 6.5.3

Determine the equation of the plane containing the points $E(0,0,3)$, $F(2,0,3)$, $G(2,5,3)$, and $H(0,5,3)$.

Determine the equation of the plane containing points *O, E, F*

Which points are in the *y*-*z* plane?

Example 6.5.4

Given $\overrightarrow{OP}=(2,b,c)$ and $\overrightarrow{OP}=(a,3,0)$ determine *a, b,* and *c*. **Why can the three unknowns be determined?**

Example 6.5.5

Plot the point $P(-2,1,3)$ and draw the associated position vector. Label each "corner" of your "3-D box".

Example 6.5.6

Plot the points $A(-1,3,0)$, $B(2,3,1)$ and $C(0,3,4)$ and give an equation for the plane containing the points.

Class/Homework for Section 6.5

Pg. 316 – 318 #2, 3, 5 – 7, 9, 13 – 16