# 14-1 Vectors in 3D

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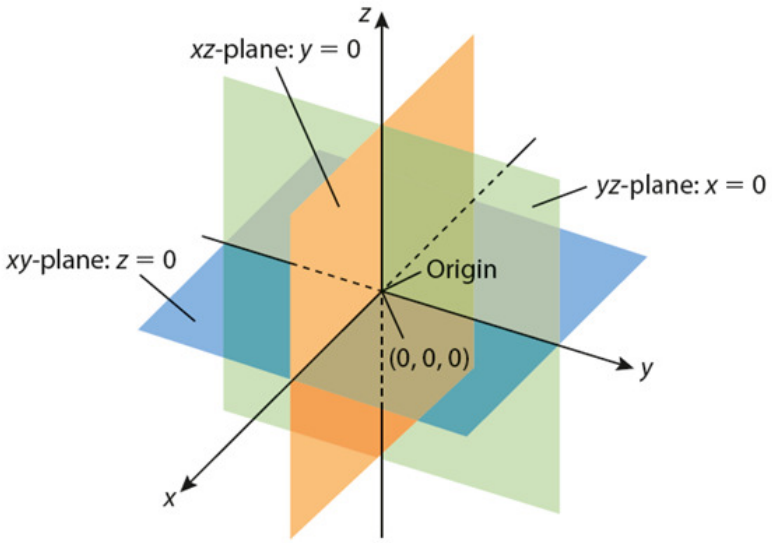
# 3D Coordinate System

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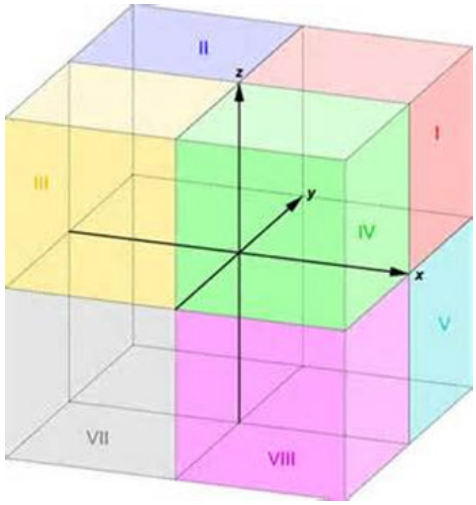
# The 3D Coordinate system divide space into 8 octants

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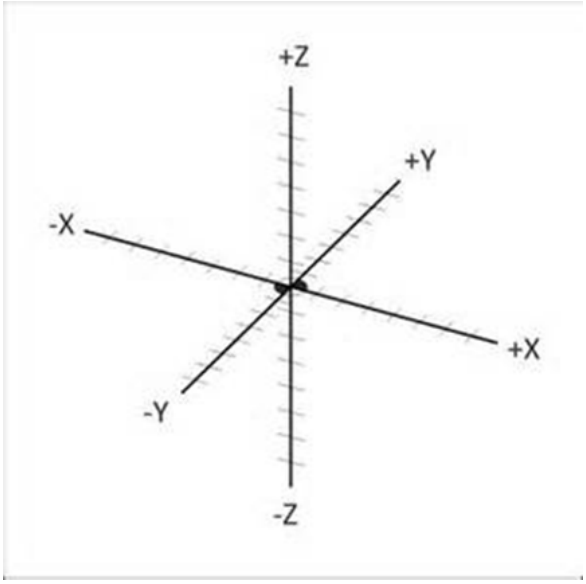
# Axes Numbering

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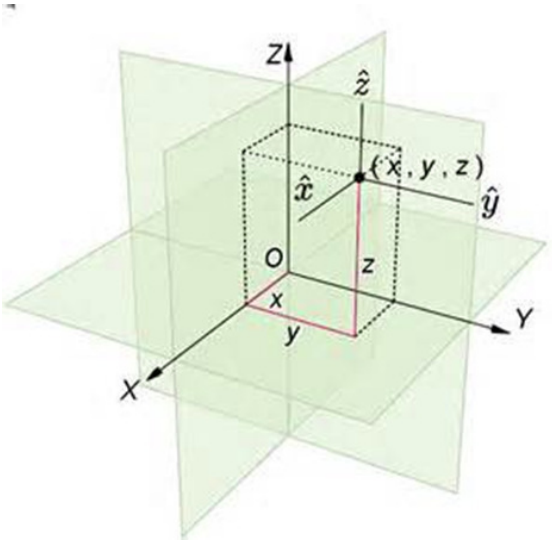
# Plotting Points in 3D

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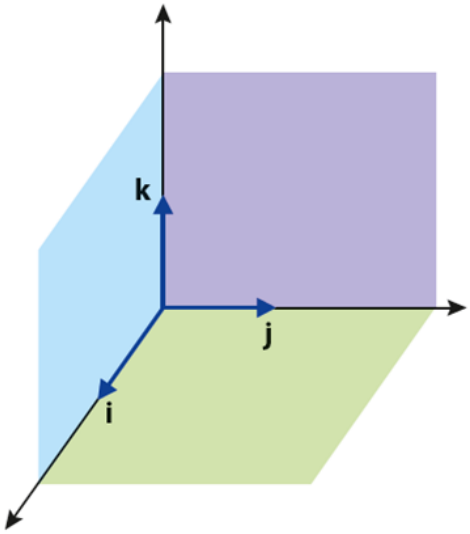
# Base Vectors in 3D




i = unit vector in the direction of the positive x-axis

j = unit vector in the direction of the positive y-axis.

k = unit vector in the direction of the positive z-axis.

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$$\vec{v} = \langle x, y, z \rangle = \begin{pmatrix} x \\ y \\ z \end{pmatrix} = x\mathbf{i} + y\mathbf{j} + z\mathbf{k}$$

The magnitude of a vector in 3D

$$|\vec{v}| = \sqrt{x^2 + y^2 + z^2}$$

Because we now have 3 dimensions, we will have to redefine the meaning of direction (cannot think of it as a slope nor as an angle from the positive x-axis).

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Two vectors are parallel if one of them is a scalar multiple of the other.

If $\vec{u} = \langle x, y, z \rangle$ and $\vec{v} = k\langle x, y, z \rangle = \langle kx, ky, kz \rangle$ ,

then $\vec{u} \parallel \vec{v}$ .

Example: $\vec{u}$ , $\vec{v}$ , and $\vec{w}$ are all parallel

$\vec{u} = \langle 2, 3, -5 \rangle$

$\vec{v} = \langle 8, 12, -20 \rangle$

$\vec{w} = \left\langle 1, \frac{3}{2}, -\frac{5}{2} \right\rangle$

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Ex1. Given the points A (3, -1, 2) and B (6, 5, -3)

a.) Find the components of vector $\overrightarrow{AB}$

$\overrightarrow{AB} = B - A = \langle 3, 6, -5 \rangle$

b.) Find the components of vector $\overrightarrow{BA}$

$\overrightarrow{BA} = \langle -3, -6, 5 \rangle$

c.) Find the components of vector $2\overrightarrow{AB}$

$2\overrightarrow{AB} = \langle 6, 12, -10 \rangle$

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d.) Find $|\overrightarrow{AB}|$

$\sqrt{3^2+6^2+(-5)^2}$

$= \sqrt{70}$

e.) Find $|2\overrightarrow{AB}|$ $\sqrt{6^2+12^2+(-10)^2} =$

$\sqrt{280} = 2\sqrt{70}$

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Ex2. $\vec{v} = 3\mathbf{i} - 2\mathbf{j} + 5\mathbf{k}$

a.) Find a unit vector in the direction of $\vec{v}$

$|\vec{v}| = \sqrt{3^2 + (-2)^2 + 5^2} = \sqrt{38}$

$\frac{3}{\sqrt{38}}\mathbf{i} - \frac{2}{\sqrt{38}}\mathbf{j} + \frac{5}{\sqrt{38}}\mathbf{k}$

b.) Find vector that is 12 units long in the same direction as $\vec{v}$

$\frac{36}{\sqrt{38}}\mathbf{i} - \frac{24}{\sqrt{38}}\mathbf{j} + \frac{60}{\sqrt{38}}\mathbf{k}$

Ex3. Determinethe relationship between the coordinates of point M (x, y, z) so that the points M, A (3, 1, 5), and B (-1, 2, -3) are collinear.

$\overrightarrow{AB} \parallel \overrightarrow{AM}$

$\langle -4, 1, -8 \rangle \parallel \langle x-3, y-1, z-5 \rangle$

$k\langle -4, 1, -8 \rangle = \langle x-3, y-1, z-5 \rangle$

$k\langle -4, 1, -8 \rangle + (3, 1, 5) = (x, y, z)$

$k \in \mathbb{R} \quad k \neq 0, 1$

$M = (3, 1, 5) + k\langle -4, 1, -8 \rangle$

$k = 2 \quad M = (3, 1, 5) + (-8, 2, -16)$

$M = (-5, 3, -11)$

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pg 634 #1ad, 2ac, 3b, 5ac, 6a, 8b, 9c, 10, 11a, 13 (14, 15, or 16), 17, 19, 20, 23, 25

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