Vectors:

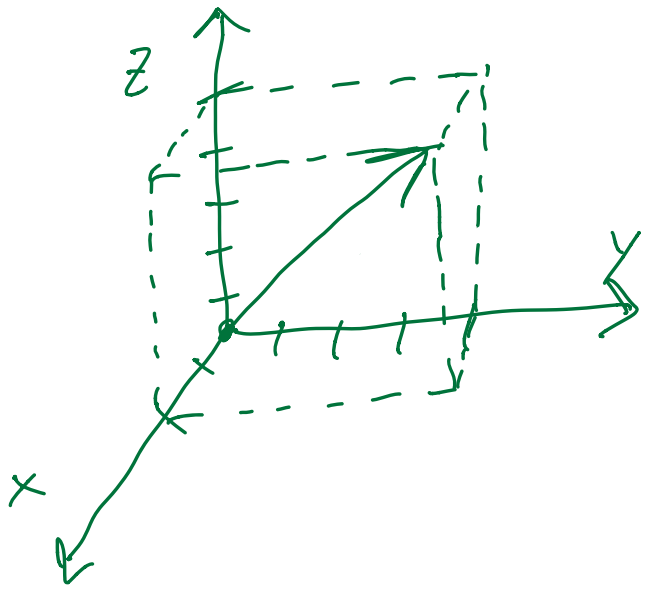
Q: What is a vector?

- Magnitude
- Direction

$\vec{r} = \langle r_x, r_y, r_z \rangle$

$\vec{r} = r_x \hat{x} + r_y \hat{y} + r_z \hat{z}$

Ex: $\vec{r} = \langle 2, 4, 5 \rangle$



Length (mag) of a vector?

$|\vec{r}| =$

$|\vec{r}| = \sqrt{r_x^2 + r_y^2 + r_z^2}$

What is the magnitude of $\langle 2, 4, 5 \rangle$?

A: 6.7

What else w/ vectors?

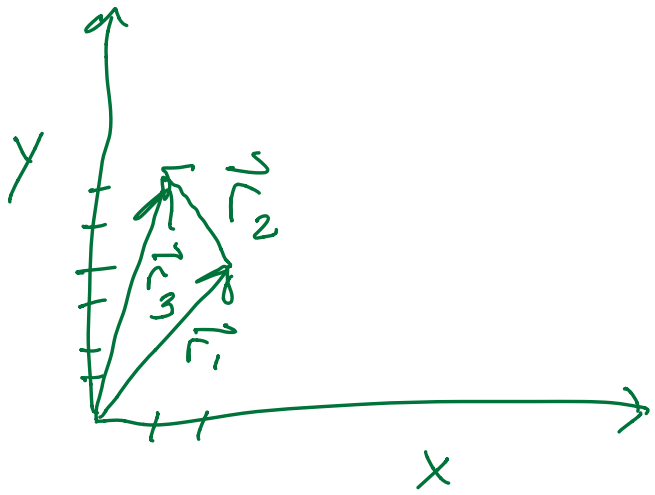
Vector Addition

Vector Addition

$\vec{r}_1 = \langle 2, 4, 0 \rangle$

$\vec{r}_2 = \langle -1, 2, 0 \rangle$

$\vec{r}_3 = \vec{r}_1 + \vec{r}_2 = \langle 1, 6, 0 \rangle$



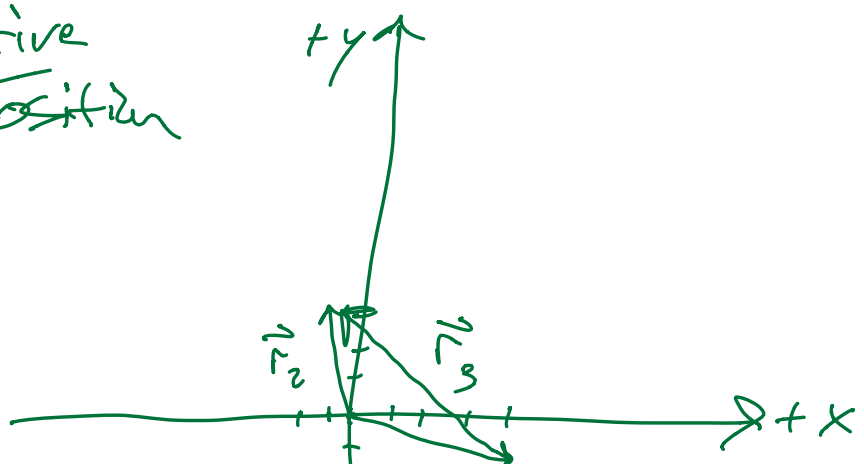
Subtraction

$\vec{r}_1 = \langle 4, -1, 0 \rangle$

$\vec{r}_2 = \langle -2, 3, 0 \rangle$

$\vec{r}_3 = \vec{r}_2 - \vec{r}_1 = \langle -6, 4, 0 \rangle$

relative position



$\vec{r}_1$

Equivalent to:

$\vec{r}_1 + \vec{r}_3 = \vec{r}_2$

$\Rightarrow \vec{r}_2 - \vec{r}_1 = \vec{r}_3$ ✓

Scalar multiplication

$k\vec{r} =$

$= \langle kr_x, kr_y, kr_z \rangle$

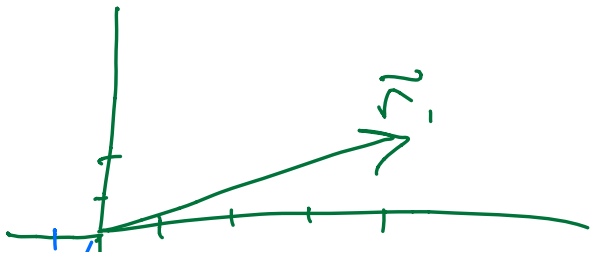
Does direction change?

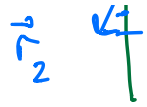
$5\vec{r}$

$-\frac{1}{2}\vec{r}$

$\vec{r}_1 = \langle 4, 2, 0 \rangle$

$\vec{r}_2 = -\frac{1}{4}\vec{r}_1 = \langle -1, -\frac{1}{2}, 0 \rangle$





What if I want a vector in direction of $\vec{r}_1$ w/ len of 1? What is this called?

Unit vector

$\vec{r}_1 = \langle 4, 2, 0 \rangle$

$\hat{r}_1 = ?$

$\hat{r}_1 = \frac{1}{|\vec{r}_1|} \vec{r}_1 \qquad |\vec{r}_1| \approx 4.47$

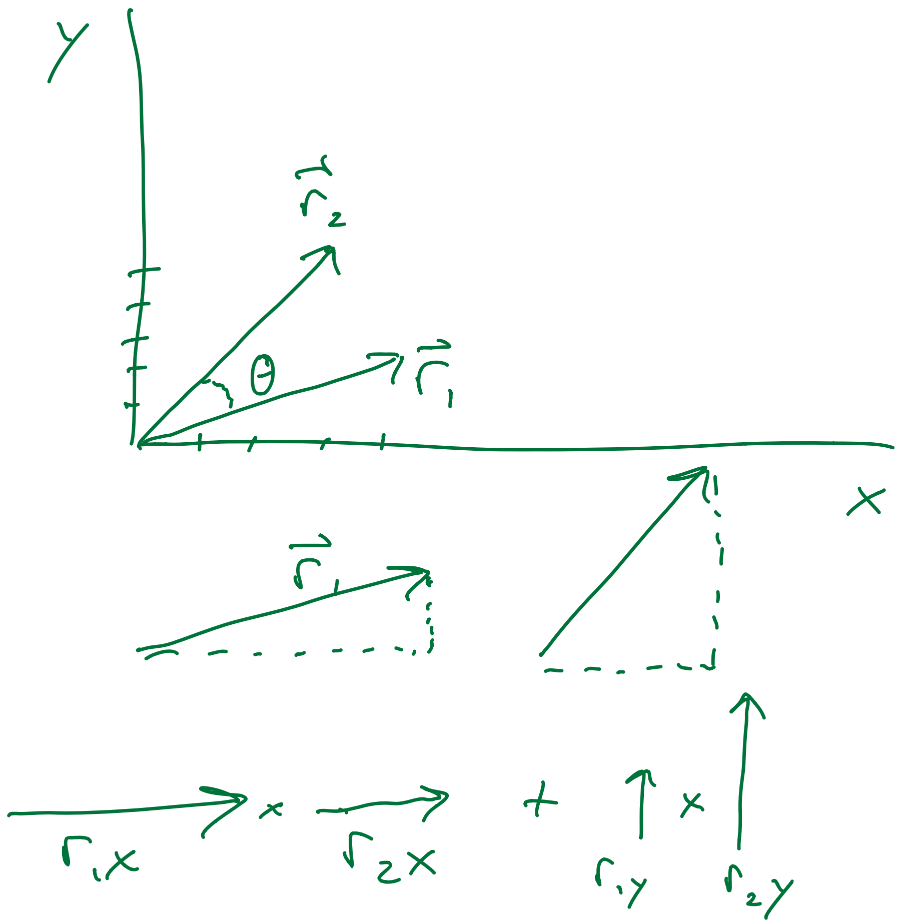
$\hat{r}_1 = \langle 0.89, 0.44, 0 \rangle$

Dot product..

Can we multiply two vectors together?

$\vec{r}_1 = \langle 4, 2, 0 \rangle$

$\vec{r}_2 = \langle 3, 5, 0 \rangle$



$$\vec{r}_1 \cdot \vec{r}_2 = |\vec{r}_1||\vec{r}_2| \cos\theta$$

Cross Product

Another way to mult vectors

Any other way to multiply vectors?

$\vec{r}_1 \times \vec{r}_2 = \vec{r}_3$ ← still a vector!

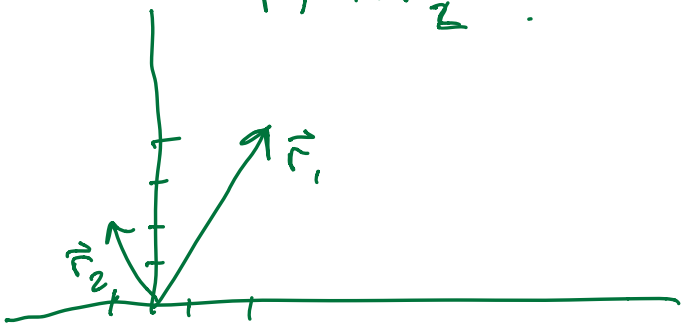
$|\vec{r}_1 \times \vec{r}_2| = |\vec{r}_1||\vec{r}_2|\sin\theta$

Direction?

$\vec{r}_1 = \langle 2, 4, 0 \rangle$

$\vec{r}_2 = \langle -1, 2, 0 \rangle$

$\vec{r}_1 \times \vec{r}_2$?

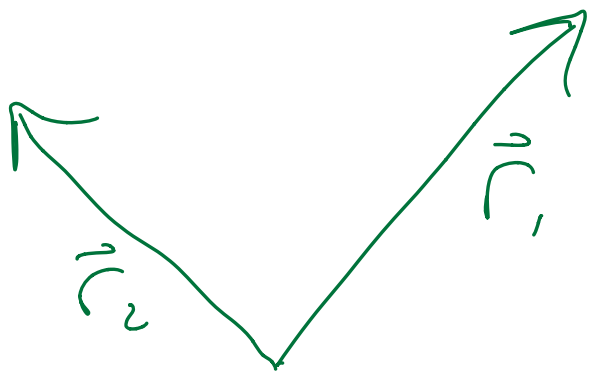


First $|\vec{r}_1 \times \vec{r}_2|$, then direction

$|\vec{r}_1|, |\vec{r}_2|$

θ? (use dot product)

Direction? RHR



$$Dir = \hat{z} \text{ (out of page)}$$