Math and Kinematics - Vectors

Note Title 8/23/2010

Welcome to AP Physics C!
Since you are here, I am assuming that you know a few things about physics. Check out page 2 of your "Math and Kinematics" packet for the list of things you should know. If there is anything in there that you are unsure about, check your book and my AP Physics B lecture notes, then come ask me for help.

So lets get started on the first day's topic...

OLD CONCEPTS

Vectors

Scalar - Magnitude, no direction (speed, distance)
5 m/s 10 m

Vector - Magnitude and direction (velocity, displacement)
5 m/s in +y direction 10 m North

Multiplication

scalar x scalar = scalar
10m x 2 = 20m

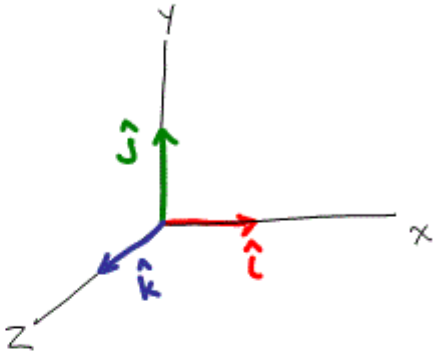
scalar x vector = vector
3 x $9.8\ m/s^2$ down = $29.4\ m/s^2$ down

vector x vector = ??? (we'll get to this later)

New Vector Stuff

Unit Vector Notation

- Unit Vector: A vector in some direction with a magnitude = 1.
- Unit Vectors used in class:



$\hat{i}$ - a unit vector in the "x" direction

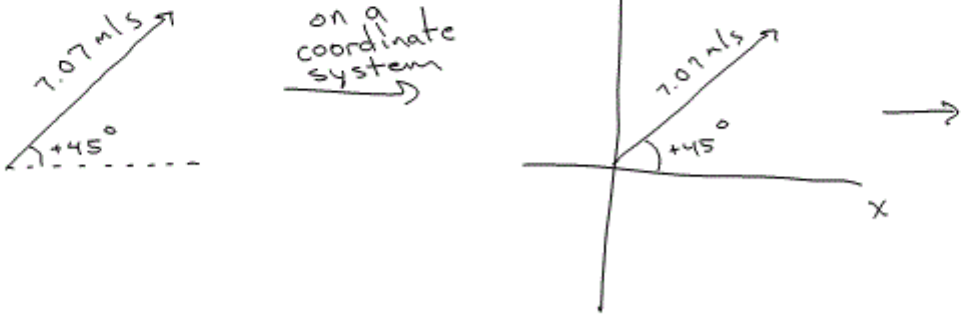
$\hat{j}$ - a unit vector in the "y" direction

$\hat{k}$ - a unit vector in the "k" direction

- By using unit vectors, we have a really simple way to express goofy directions in 2 or 3 dimensions.

Converting from Magnitude/Direction ⟶ Unit Vector Notation

Example: Vector $\vec{A} = 7.07$ m/s at an angle of $+45^\circ$ degrees. Express $\vec{A}$ in vector notation:



x-component:

$= (7.07 \text{ m/s}) \cos 45^\circ$

$= 5 \text{ m/s } \hat{i}$

y-component:

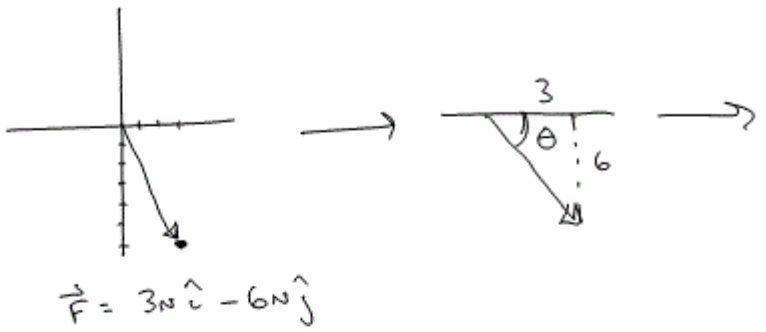
$= (7.07 \text{ m/s}) \sin 45^\circ$

$= 5 \text{ m/s } \hat{j}$

Answer: $\vec{A} = 5 \text{ m/s } \hat{i} + 5 \text{ m/s } \hat{j}$

Converting from Unit Vector → Magnitude / Direction Notation

Example: Find the magnitude and direction of the unit vector $\vec{F} = (3.0\,N)\,\hat{i} - (6.0\,N)\,\hat{j}$



$\vec{F} = 3N\,\hat{i} - 6N\,\hat{j}$

magnitude:

$$= \sqrt{3^2 + 6^2} = 6.7N$$

direction:

$$\tan\theta = \frac{6}{3}$$

$$\theta = \tan^{-1}(2)$$

$$\theta = 63^\circ$$

$\vec{F} = 6.7N$ in the -63° direction

Vector Addition Using Unit Vectors

Example: Add $3\hat{i} - 10\hat{j}$ and $-4\hat{i} + 2\hat{j}$:

$$(3-4)\,\hat{i} + (-10+2)\,\hat{j} = \boxed{-\hat{i} - 8\hat{j}}$$

Example: $\vec{A} = 4m\,\hat{i} - 10m\,\hat{j} + 2m\,\hat{k}$

$\vec{B} = 2m\,\hat{i} + 2m\,\hat{j} - 10m\,\hat{k}$

Subtract $2\vec{A} - 3\vec{B}$:

$$2\vec{A} = 2(4m\,\hat{i} - 10m\,\hat{j} + 2m\,\hat{k}) = 8m\,\hat{i} - 20m\,\hat{j} + 4m\,\hat{k}$$

$$-3\vec{B} = -3(2m\,\hat{i} + 2m\,\hat{j} - 10m\,\hat{k}) = -6m\,\hat{i} - 6m\,\hat{j} + 30m\,\hat{k}$$

$$\boxed{2\vec{A} - 3\vec{B} = 2m\,\hat{i} - 26m\,\hat{j} + 34m\,\hat{k}}$$