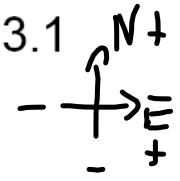
Physics 122: Application of Vectors Examples

6. An object initially has a velocity of 15 m/s [W42°N] and experiences an acceleration of 3.1 m/s^2 [E75°S] for 12.6 seconds. What is the displacement in that time?



$v_0 = 15\ m/s\ [W42°N]$; $a = 3.1\ m/s^2\ [E75°S]$

East

$v_{oE} = -15\cos 42°$

$= -11.1\ m/s$

$a_E = 3.1\cos 75$

$= 0.8\ m/s^2$

North

$v_{oN} = 15\sin 42$

$= 10\ m/s$

$a_N = -3.1\sin 75$

$= -3.0\ m/s^2$

$$\vec{d_f} = \vec{d_o} + \vec{v_o}t + \frac{1}{2}\vec{a}t^2$$

$$d_{fE} = d_{oE} + v_{oE} + \frac{1}{2}a_E t \qquad d_{fN} = d_{oN} + v_{oN}t + \frac{1}{2}a_N t^2$$

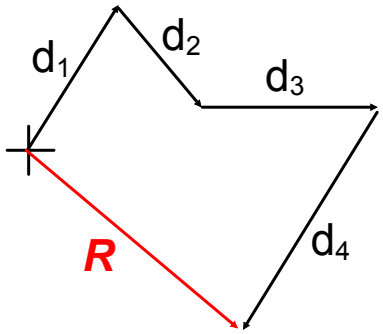
$$|\vec{d_f}| = \sqrt{(d_{fE})^2 + (d_{fN})^2}$$

$$\theta = \tan^{-1}\left|\frac{d_{fN}}{d_{fE}}\right|$$

Finding a Missing Vector Given the Resultant

These problems require you to think about how all the vectors add together and develop your own vector addition formula.

For a visual example, take the following displacement vectors that add to give the resultant, ***R***:



The concept of finding the resultant, ***R***, is to add all the vectors together:

$$\boldsymbol{R} = d_1 + d_2 + d_3 + d_4$$

Now suppose you know the value of ***R***, but are missing the fourth displacement vector d_4, you need a formula for which to apply our steps in solving these vector problems.

Not to worry, the formula is not some stupid-crazy thing pulled out of thin air; rather it is basic equation solving. The formula for d_4 is below:

$$\boldsymbol{R} - d_1 - d_2 - d_3 = d_4$$

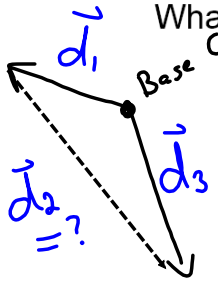
*subtract all other vectors to the other side.

Flipping it around to a format we are used to:

$$d_4 = \boldsymbol{R} - d_1 - d_2 - d_3$$

Now we are ready to apply our strategies for solving a vector problem since we have a governing formula.

7. As you hike along a trail yo
from base camp. When you ar
call for help comes in from a lo
[E65°S]. How far are the stran
What heading should you set t



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

$\vec{d}_2 = \vec{d}_3 - \vec{d}_1$

$d_{1E} = -8.4\cos 18$
$= -8.0$ km

$d_{1N} = 8.4\sin 18$
$= 2.6$ km

$d_{3E} = 5.5\cos 65$
$= 2.3$ km

$d_{3N} = -5.5\sin 65$
$= -5.0$ km

$d_{2E} = d_{3E} - d_{1E}$
$= 2.3 - (-8.0)$
$= 10.3$ km

$d_{2N} = d_{3N} - d_{1N}$
$= -5.0 - (2.6)$
$= -7.6$ km

$|\vec{d}_2| = \sqrt{(d_{2E})^2 + (d_{2N})^2}$
$= \sqrt{(10.3)^2 + (-7.6)^2}$
$= 12.8$ km

keep 4 decimal places

$\theta = \tan^{-1}\left|\frac{d_{2N}}{d_{2E}}\right| = \tan^{-1}\left(\frac{7.6}{10.3}\right) = \tan^{-1}(0.73)$

0.7379

$\theta = 36°$

$\vec{d}_2 = 12.8$ km [E 36° S]