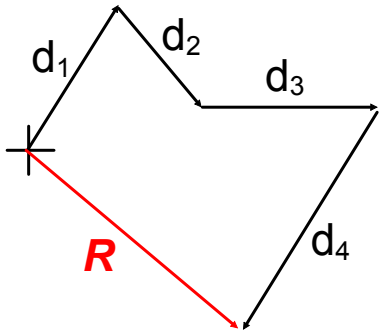
Finding a Missing Vector Given the Resultant

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.

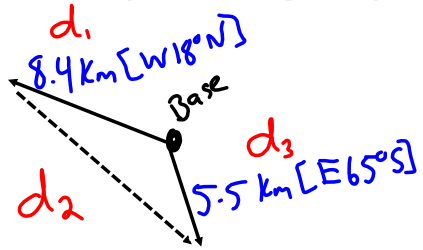
Flipping it around to a format we are used to:

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

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

Physics 122: Application of Vectors Examples

7. As you hike along a trail you track your location from base camp. When you are 8.4 km [W18°N] a call for help comes in from a location 5.5 km [E65°S]. How far are the stranded hikers from you? What heading should you set to go help them?



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

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

$d_{1E} = -8.4\cos 18 = \underline{-8.0}$ $d_{1N} = 8.4\sin 18 = \underline{2.6}$

$d_{3E} = 5.5\cos 65 = \underline{2.3}$ $d_{3N} = -5.5\sin 65 = \underline{-5.0}$

$d_{2E} = d_{3E} - d_{1E}$

$= 2.3 - (-8)$

$= \underline{10.3\ km}$

$d_{2N} = d_{3N} - d_{1N}$

$= -5.0 - (2.6)$

$= \underline{-7.6\ km}$

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

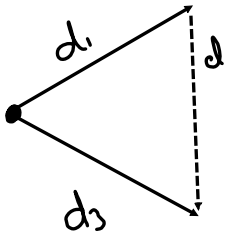
$$|\vec{d}_2| = 12.8\ km$$

$$\theta = \tan^{-1}\left|\frac{d_{2N}}{d_{2E}}\right| = \tan^{-1}\left(\frac{7.6}{10.3}\right) = 36^\circ$$

$$\boxed{\vec{d}_2 = 12.8\ km\ [E\ 36^\circ S]}$$

Physics 122: Application of Vectors Examples

8. An inept boating tour guide takes you to a point 26 km [E33°N] from port when in fact you should be located 30 km [E33°S]. To get to your proper destination in 0.75 hours, with what velocity should the tour boat travel?



$$d_3 = d_1 + d_2$$

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

$d_{3E} = 30\cos 33 = 25.2$ $\quad d_{3N} = -30\sin 33 = -16.3$

$d_{1E} = 26\cos 33 = 21.8$ $\quad d_{1N} = 26\sin 33 = 14.2$

$$d_{2E} = d_{3E} - d_{1E}$$
$$= 25.2 - 21.8$$
$$= 3.4 \text{ km}$$

$$d_{2N} = d_{3N} - d_{1N}$$
$$= -16.5 - 14.2$$
$$= -30.7 \text{ km}$$

$$|\vec{d}_2| = \sqrt{(d_{2E})^2 + (d_{2N})^2} = \sqrt{(3.4)^2 + (30.7)^2}$$

$$|\vec{d}_2| = 30.9 \text{ km}$$

$$\theta = \tan^{-1}\left|\frac{d_{2N}}{d_{2E}}\right| = \tan^{-1}\left(\frac{30.7}{3.4}\right) = 84°$$

$$\vec{d}_2 = 30.9 \text{ km } [E\ 84°\ S]$$

$$\vec{v}_{avg} = \frac{\vec{d}_2}{t} = \frac{30.9 \text{ km}}{0.75 \text{ h}}$$

$$\boxed{\vec{v}_{avg} = 41.2 \frac{\text{km}}{\text{h}} [E\ 84°\ S]}$$