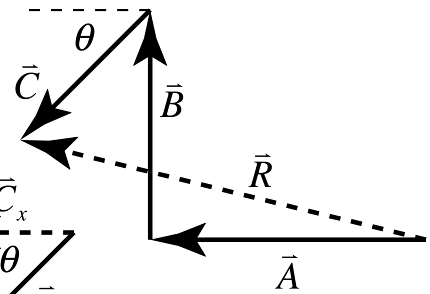
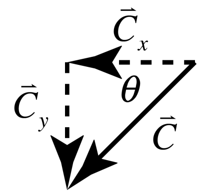
Flipping Physics Lecture Notes:
A Visually Complicated Vector Addition Problem using Component Vectors



Example Problem: Slow Velocity Racer races 60.0 cm West, then turns North and drives for 50.0 cm. She then turns and slowly meanders another 40.0 cm SW. What was her total displacement?

$\vec{A} = 60.0cm\ W$, $\vec{B} = 50.0cm\ N$, $\vec{C} = 40.0cm\ SW$ &
$\vec{A} + \vec{B} + \vec{C} = \vec{R} = ?$



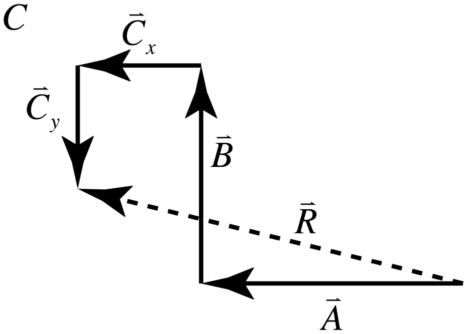
Break vector $\vec{C}$ in to its components.

$$\sin\theta = \frac{O}{H} = \frac{\vec{C}_y}{C} \Rightarrow \vec{C}_y = \vec{C}\sin\theta = 40\sin(45)$$

$$\Rightarrow \vec{C}_y = 28.284cm\ South = -28.284cm$$

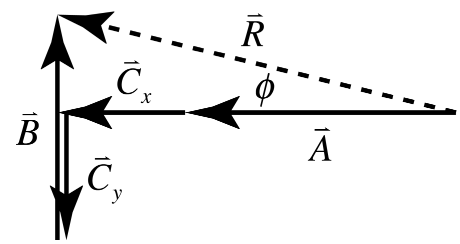
$$\cos\theta = \frac{A}{H} = \frac{\vec{C}_x}{\vec{C}} \Rightarrow \vec{C}_x = \vec{C}\cos\theta = 40\cos(45)$$

$$\Rightarrow \vec{C}_x = 28.284cm\ West = -28.284cm$$



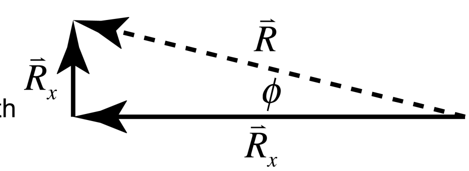
You should recognize that the sine and cosine of 45° are exactlty the same and therefore the magnitudes of $\vec{C}_x$ & $\vec{C}_y$ are the same (but the directions are different).

Redraw the Vector Diagram. Some of you might not see the right triangle, however, remember the Associative Property of Vector Addition! The order you add the vectors in doesn't matter. So let's try adding them in a different order …



So now we have a right triangle and set up a table to help determine the components of the resultant vector:

Vector	x-direction (cm)	y-direction (cm)
$\vec{A}$	-60	0
$\vec{B}$	0	50
$\vec{C}$	-28.284	-28.284
$\vec{R}$	$\vec{R}_x = -60 - 28.284 = -88.284$	$\vec{R}_y = 50 - 28.284 = 21.716$



And if you didn't see the right triangle before, perhaps you can see it now with the redrawn vector diagram with the components of the Resultant Vector.

Now we can use SOH CAH TOA and the Pythagorean theorem to find the Resultant Vector, $\vec{R}$.

$$a^2 + b^2 = c^2 \Rightarrow R^2 = R_x^2 + R_y^2 \Rightarrow R = \sqrt{R_x^2 + R_y^2} = \sqrt{(-88.284)^2 + (21.716)^2} = 90.916cm$$

$$\&\ \sin\phi = \frac{O}{H} = \frac{R_y}{R} \Rightarrow \phi = \sin^{-1}\left(\frac{R_y}{R}\right) = \sin^{-1}\left(\frac{21.716}{90.916}\right) = 13.819°$$

$$\Rightarrow \boxed{\vec{R} \approx 90.9cm\ @\ 13.8°\ N\,of\,W}$$