# Converting between Standard and Component Form

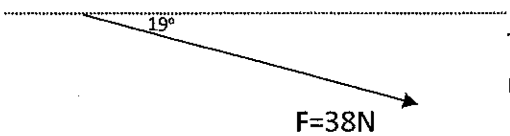


It will be important for us to be able to work with vectors in both **standard** and **component** form. It is also important that we can convert a vector in standard form to a vector in component form, and to convert a vector in component form to a vector in standard form.

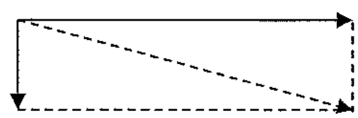
## 1. Standard to Component

Consider the following vector:

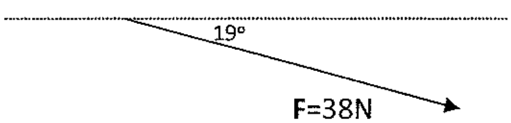
**F** = 38N [19° below +x]



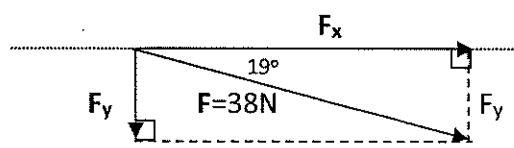

This vector points right AND down



But how do we find the x and y vectors (called **components**)? TRIGONOMETRY!




Now if we add a couple of lines we make 2 right triangles.




This vector can be described using its length, or magnitude and its direction, or angle.

We say: **F** = 38N [19° below +x] (Below because it is down, +x because it is to the right)

From trigonometry we can see: sin 19°= $\frac{F_y}{38N}$

cos 19°= $\frac{F_x}{38N}$

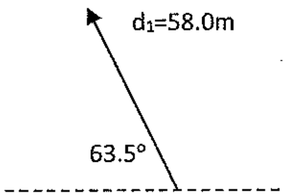
tan 19°= $\frac{F_y}{F_x}$

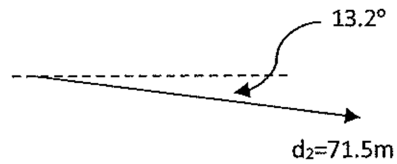
And so we can find the magnitudes of $\mathbf{F_x}$ and $\mathbf{F_y}$.

The direction is found just by looking at the diagram.

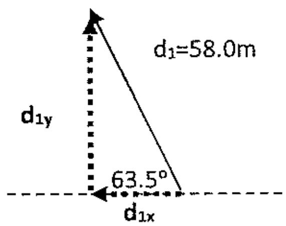
**Example 1:**

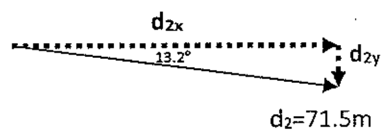
Let's illustrate with an example. Consider the following two vectors given in standard form.




**$d_1$** points left and up, **$d_2$** points right and down. The components of the vector simply tell us how much left or right and how much up or down. We can diagram this in a couple of ways.




This creates two right triangles! This is because BY DEFINITION ***the components of a vector are always perpendicular to each other.*** That's good because we already know how to solve right angled triangles!

Consider **$d_1$** first. $\cos(63.5°)=\frac{d_{1x}}{d_1} \Longrightarrow d_{1x} = d_1 \cos(63.5°) = 58.0\text{m} \cos(63.5°) = 25.87947316\text{m}$

Now we need to indicate that it points left. $\mathbf{d_{1x}} = -\,25.87947316\text{m}\ \mathbf{x}$

$\sin(63.5°)=\frac{d_{1y}}{d_1} \Longrightarrow d_{1y} = d_1 \sin(63.5°) = 58.0\text{m} \sin(63.5°) = 51.90619297\text{m}$

Now we need to indicate that it points up. $\mathbf{d_{1y}} = 51.90619297\text{m}\ \mathbf{y}$

We now know $d_1$ in component form.

$$d_1 = -25.87947316\text{m}\ \mathbf{x} + 51.90619297\text{m}\ \mathbf{y}$$

Let's try $\mathbf{d_2}$ together: $\cos(13.2°)=\frac{d_{2x}}{d_2}$ $\Rightarrow$ $d_{2x} = d_2 \cos(13.2°) =$ $\underline{71.5}$ m $\cos(\underline{13.2}°) = \underline{69.61089156}$ m

Now we need to indicate that it points $\underline{\text{right}}$. $d_{2x} = \underline{69.6108915\text{m}}\ \hat{x}$

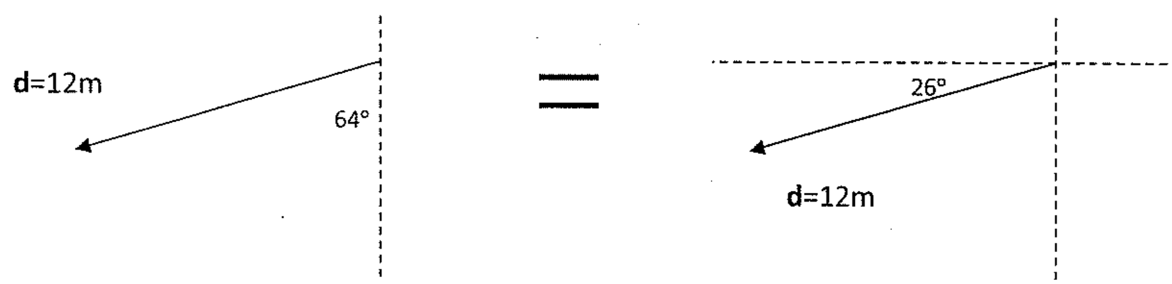
$\sin(13.2°)=\frac{d_{2y}}{d_2}$ $\Rightarrow$ $d_{2y} = \underline{d_2 \sin 13.2°} = \underline{71.5\text{m} \sin 13.2°} = \underline{16.25858195}$ m

Now we need to indicate that it points $\underline{\text{down}}$. $d_{2y} = \underline{-16.25858195\text{m}}\ \hat{y}$

We now know $\mathbf{d_2}$ in component form.

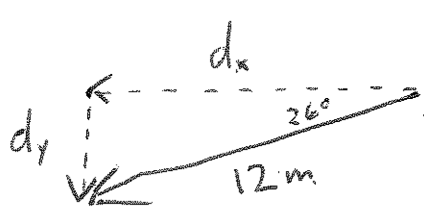
$$\mathbf{d_2} = \underline{69.6\text{m}\ \hat{x} + (-16.3\text{m})\ \hat{y}}$$

**Example 2:**



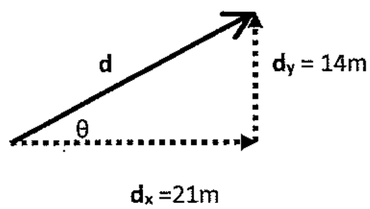

**d** = 12m [64° left of –y] = 12m [26° below –x]

Sketch and find the x and y components of the above displacement vector



## 2. Component to Standard

This is fairly straight forward. All we need to be able to do is solve another right triangle.
Consider the following vector in component form:



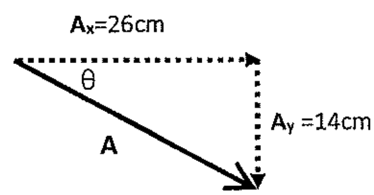

We can simply use Pythagoras' Theorem to find the magnitude, and the tangent ratio to find the direction.

$$d_T = \sqrt{d_{tx}^2 + d_{ty}^2} \qquad \theta = \tan^{-1}\frac{d_{ty}}{d_{tx}}$$

$d_T$= 25 m [34° above + x]

Example: **A** = 26cm **x** + (-14cm) **y**

1. Sketch the vector:




2. Use Pythagoras' Theorem to find the magnitude:

$$A = \sqrt{A_x^2 + A_y^2} = \sqrt{26cm^2 + 14cm^2} = \ldots.. \ 29.52964612 \text{ cm}$$

3.0×10 cm

3. Use the arctangent function to find the angle:

$$\theta = tan^{-1}\frac{A_y}{A_x} = tan^{-1}\frac{14cm}{26cm} = \ldots. \ 28.30075577°$$

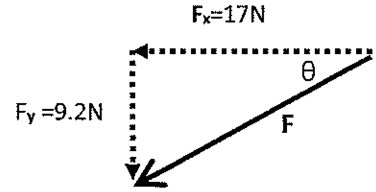
4. Write the vector in standard notation:

A= 3.0×10 cm [ 28 ° below + x ]

Try these on your own:

F = -17N **x** + (-9.2N) **y**

1. Sketch the vector:




$\vec{F} = 19N$ [28° below -x]

B= 0.060T **x** + 0.19T **y**

$\vec{B} = 0.20T$ [72° above +x]

Now: Practice, practice, practice! You need to be able to do these operations quickly (you should be able to convert either direction in 2 minutes or less) and accurately (any mistake in the basic math will lead to wrong answers elsewhere.)

The jump from 1-D to 2-D is one of the biggest differences between Physics 11 and Physics 12. If you can master these skills ***now***, before we start introducing brand new physics concepts, you will have a much greater chance for success!