Converting between Standard and Component Form N3

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:

$\rightharpoonaccent{F}$ = 38N [19o below +x]

19o

 This vector points

 right AND down

 F=38N

But how do we find *how much right? How much down?*

In other words, how do we find the x and y vectors (called **components**) that make up this vector?

TRIGONOMETRY!

 **Fx**

 19o Now if we add a few 19o

 lines we make right **Fy** **F**=38N Fy

 **F**=38N triangles.

 Fx

 Fy

 38N

From trigonometry we can see: sin 19o=$ \frac{F\_{y}}{38N}$

 cos 19o=$\frac{ }{ }$

 tan 19o= $\frac{ }{ }$

And so from the trigonometry, and a little algebra, we can find the magnitudes of **Fx** and **Fy**.

 Fx = 38Ncos(19o) =

 Fy = 38Nsin(19o) =

The direction is found just by looking at the diagram. Use + and -, $\hat{x}$ and $\hat{y}$ to indicate direction.

 $\rightharpoonaccent{F}\_{x}$= 35.9297…N $\hat{x}$

$\rightharpoonaccent{F}\_{y}$= -12.3715…N$ \hat{y}$

**Example 2:**

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

 13.2o

 d1=58.0m

 d2=71.5m

 63.5o

$\rightharpoonaccent{d}$**1** points left and up, $\rightharpoonaccent{d}$**2** points right and down. The x and y **components** of the vector simply tell us how much left or right and how much up or down. We can show this with right angled triangles.

 **d2x**

 58.0m 13.2o  **d2y**

 **d1y**

 d2=71.5m

 63.5o

 **d1x**

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 **d1** first.

 58m

 d1y

 d1x

So…

 cos(63.5o)= $\frac{d\_{1x}}{d\_{1}}$ d1x = d1 cos(63.5o) = 58.0m cos(63.5o) = 25.87947316m

Now we need to indicate that it points left. $\rightharpoonaccent{d}$**1x** = **-** 25.87947316m $\hat{x}$

And…

 sin(63.5o)= $\frac{d\_{1y}}{d\_{1}}$ d1y = d1 sin(63.5o) = 58.0m sin(63.5o) = 51.90619297m

Now we need to indicate that it points up. $\rightharpoonaccent{d}$**1y** = 51.90619297m $\hat{y}$

We now know **d1** in component form.

$\rightharpoonaccent{d}$**1** = -25.87947316m $\hat{x}$ + 51.90619297m $\hat{y}$

Let’s try **d2** together:

 cos(13.2o)= $\frac{d\_{2x}}{d\_{2}}$ d2x = d2 cos(13.2o) = \_\_\_\_\_\_m cos(\_\_\_\_\_o) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_m

Now we need to indicate that it points \_\_\_\_\_\_\_\_. $\rightharpoonaccent{d}$**2x** = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 sin(13.2o)= $\frac{ }{ }$ d2y = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Now we need to indicate that it points \_\_\_\_\_\_\_\_. $\rightharpoonaccent{d}$**2y** = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

We now know $\rightharpoonaccent{d}$**2** in component form.

$\rightharpoonaccent{d}$**2** = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Example 2:**

 **d**=12m 26o

64o

 **d**=12m

 $\rightharpoonaccent{d}$ = 12m [64o left of –y] 12m [26o 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:

 **d** **dy** = 14m

 θ

 **dx** =21m

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

$\left‖\rightharpoonaccent{d}\right‖= \sqrt{d\_{tx}^{2}+ d\_{ty}^{2}}$ θ = tan-1 $\frac{d\_{ty}}{d\_{tx}}$

$\rightharpoonaccent{d}$= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Example: $\rightharpoonaccent{A}$= 26cm $\hat{x}$ + (-14cm) $\hat{y}$

1. Sketch the vector: **Ax**=26cm

θ

 **Ay** =14cm

**A**

2. Use Pythagoras’ Theorem to find the magnitude:

$\left‖\rightharpoonaccent{A}\right‖= \sqrt{A\_{x}^{2}+ A\_{y}^{2}}= \sqrt{26cm^{2}+ 14cm^{2}}$ = …..

3. Use the arctangent function to find the angle:

 θ = *tan-1* $\frac{A\_{y}}{A\_{x}}= tan^{-1}\frac{14cm}{26cm}$ = ….

4. Write the vector in standard notation:

 $\rightharpoonaccent{A}$= \_\_\_\_\_\_\_\_\_cm [ \_\_\_\_\_\_o \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ]

Try these on your own:

$\rightharpoonaccent{F}$= -17N $\hat{x }$+ (-9.2N) $\hat{y}$

1. Sketch the vector: **Fx**=17N

θ

 F**y** =9.2N

**F**

 $\rightharpoonaccent{F}$= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

 **B**= \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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!

**Practice, Practice, Practice:**