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. Most commonly vectors will be given in standard form, and our final answers will be reported in standard form. However, most of our calculations will be performed in component form. Therefore, it will be very important that we can quickly convert a vector from standard to component form and convert a vector from component to 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 $\hat{x}$ and $\hat{y}$ **components** of this vector?

TRIGONOMETRY!

 Fx

19o

 Fy

 38N

 sin 19o=$ \frac{F\_{y}}{38N}$ or $\rightharpoonaccent{F}\_{y}$ = 38N sin 19o = 12.3715… N

 cos 19o=$ \frac{ }{ }$ or $\rightharpoonaccent{F}\_{x}$ = 38N cos 19o = 35.9297… N

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}$

So we now know the components of $\rightharpoonaccent{F}$.

**Example 2:**

Consider the following two vectors given in standard form.

 $\rightharpoonaccent{d}\_{1}=58.0m [63.5^{o}$ above -$\hat{x}]$

 $\rightharpoonaccent{d}\_{2}=71.5m [13.2^{o}$ below +$\hat{x}]$

First, draw the two vectors:

 13.2o

 d1=58.0m

 d2=71.5m

 63.5o

Next, sketch in the components:

$\rightharpoonaccent{d}$**1** points left and up, $\rightharpoonaccent{d}$**2** points right and down. The $\hat{x }$and $\hat{y}$ **components** of the vector simply tell us how much left or right and how much up or down.

 d2x

 58.0m 13.2o  d2y

 d1y

 d2=71.5m

 63.5o

 d1x

Once we sketch in the components we will ALWAYS have right angled 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 $\rightharpoonaccent{d}$**1** first.

 58m

 d1y

63.5o

 d1x

 cos(63.5o)= $\frac{d\_{1x}}{d\_{1}}$ d1x = d1 cos(63.5o) sin(63.5o)= $\frac{d\_{1y}}{d\_{1}}$ d1y = d1 sin(63.5o)

 = 58.0m cos(63.5o) = 58.0m sin(63.5o)

 = 25.87947316m = 51.90619297m

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

Next, $\rightharpoonaccent{d}$**2**:

 d2x

13.2o

 d2y

 d2

**Example 2:**

$\rightharpoonaccent{d}$=12m 26o

64o

$\rightharpoonaccent{d}$=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:

 $\rightharpoonaccent{d}$ $\rightharpoonaccent{d}$**y** = 14m

 θ

 $\rightharpoonaccent{d}$x =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

$$\rightharpoonaccent{A}$$

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

$$\rightharpoonaccent{F}$$

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

$\rightharpoonaccent{B}$= 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:**