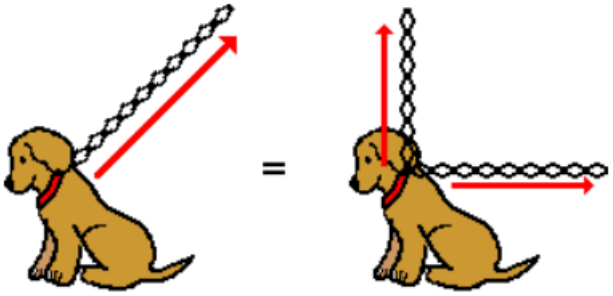
Subject Code	PHY 1	**Physics 1**
Module Code	4.0	**Vectors**
Lesson Code	4.5	**Vector Components: Applying Pythagorean Theorem**
Time Frame		30 minutes

Components	Tasks	TA[1] (min)	ATA[2] (min)
Target 	By the end of this learning guide, the student should be able to: • determine the magnitude and direction of a vector given its components.	1	
Hook 	In the previous lesson, we resolved a vector into its x- and y-components. We learned how to get the equivalent of the tension in Fluffy's chain in terms of upward and rightward components of the force.  *Figure 1.* The upward and rightward force of the chain is equivalent to the upward and rightward force by two chains .Reprinted from *Physics classroom* n.d. Retrieved July 12, 2020 from: https://www.physicsclassroom.com/class/vectors/Lesson-1/Vector-Components. Copyright 2020. But what should we do if we are given the components? How do we determine the magnitude and direction of such a vector?	1	
Ignite 	We recall that a **vector** is a quantity that has both *magnitude* and *direction*. A variety of mathematical operations can be performed with and upon vectors. In fact, we can determine the magnitude and direction of vectors by taking note of the magnitude and direction of its x- and y-components. When we add the two components of a vector, we get the *resultant vector* which simply means the sum of two or more vectors. However, in this part of our discussion, we will just add two vectors.	19	

[1] Time allocation suggested by the teacher.
[2] Actual time allocation spent by the student (for information purposes only).

The Pythagorean Theorem

The Pythagorean theorem is a useful method for determining the result of adding two (and only two) vectors that make a right angle to each other. It is a mathematical equation that relates the length of the sides of a right triangle.

The relationship among the three legs of the right triangle is given as:

$$C^2 = A^2 + B^2$$ *Equation 1*

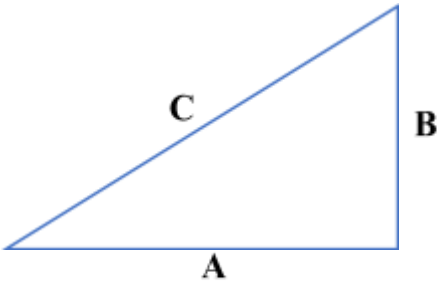


Figure 2. The Pythagorean theorem illustrated

The **Pythagorean Theorem** is the tool that we will use to *determine the* ***magnitude of the vector*** *given its components.*

The Angles of the Cartesian Plane

Before we proceed, it is important that we review the cartesian plane or the coordinate axes. The coordinate axes divide the plane into four quadrants, labeled first, second, third and fourth as shown. Angles in the first quadrant for example, lie between 0^0 and 90^0 while angles in the third quadrant lie between 180^0 and 270^0.

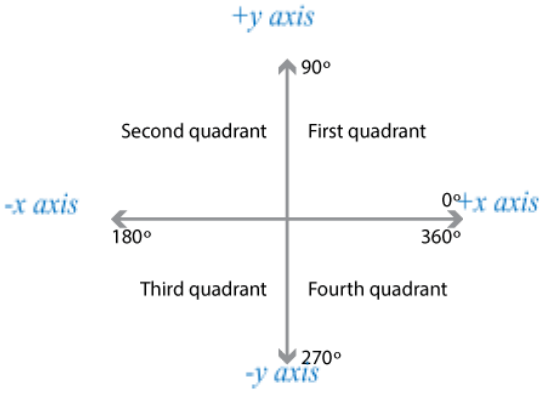


Figure 3. The scope of angles of the different quadrants of the cartesian plane

To see how these method works, consider the following problem:

> The x-component of the force in Fluffy's chain is 8.00 N to the right and the y-component is 6.00 N upward. (*Take note that the x- and y- components of the force are also vectors.)* What is the **magnitude** and **direction** of this vector given its components?

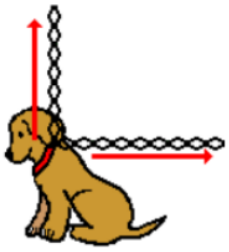


Figure 4. An example of an angled vector. Reprinted from *Physics classroom* n.d. Retrieved July 12, 2020 from: https://www.physicsclassroom.com/class/vectors/Lesson-1/Vector-Components Copyright 2020.

We will use $\vec{F}$ for the force in Fluffy's chain. Illustrating the components of the force gives us:

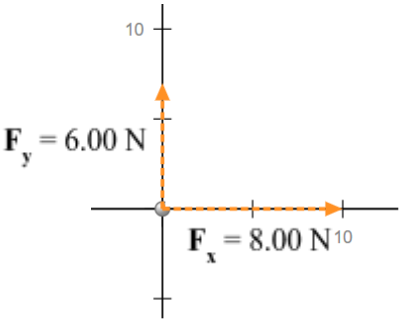


Figure 5. The x- and y- components of the force in fluffy's chain

Rearranging the components of Figure 3 to form a right triangle can be illustrated as:

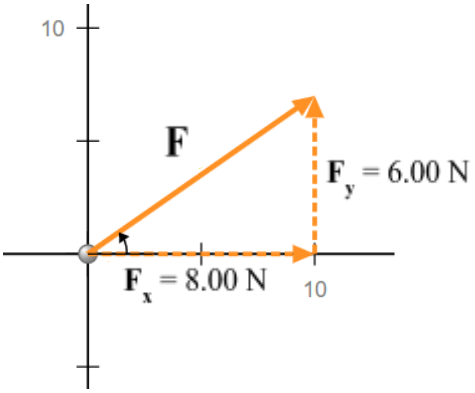


Figure 6. The x- and y- components of the force in fluffy's chain and the resultant vector

To determine the **magnitude of the vector**, we use the Pythagorean Theorem,

$$C^2 = A^2 + B^2$$

Using the variables in the problem,

$$F^2 = F_x^{\,2} + F_y^{\,2}$$

$$F = \sqrt{F_x^{\,2} + F_y^{\,2}}$$

$$F = \sqrt{(8.00N)^2 + (6.00N)^2}$$

$$F = 10.0N$$

The magnitude of the resultant vector F is 10.0 N.

It is important to note that this value is the same as the magnitude of the resultant force (tension) in Fluffy's chain in the previous lesson!

To determine the direction of vector $\vec{F}$, we consider that with the location of θ, the adjacent and opposite sides are given.

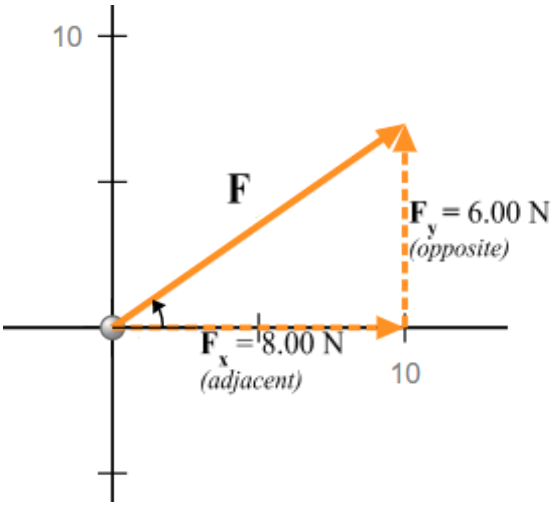


Figure 7. The x- and y- components of the force in fluffy's chain and the resultant vector

The given values in the problem are:

$\mathbf{F_x}$ = 8.00 N *(adjacent side)*

$\mathbf{F_y}$ = 6.00 N *(opposite side)*

The unknown in the problem is the direction in terms of theta (θ). Since the opposite and adjacent sides are given, we use TOA

TOA: $\tan\theta = \dfrac{opposite}{adjacent}$ *Equation 2*

$$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right)$$

$$\theta = \tan^{-1}\left(\frac{6.00N}{8.00N}\right)$$

$\theta = 36.9°$ above +x axis

It is important to note that this is about the same value as the direction of the resultant force (tension) in Fluffy's chain in the previous lesson!

To illustrate what we obtained from the problem, we have:

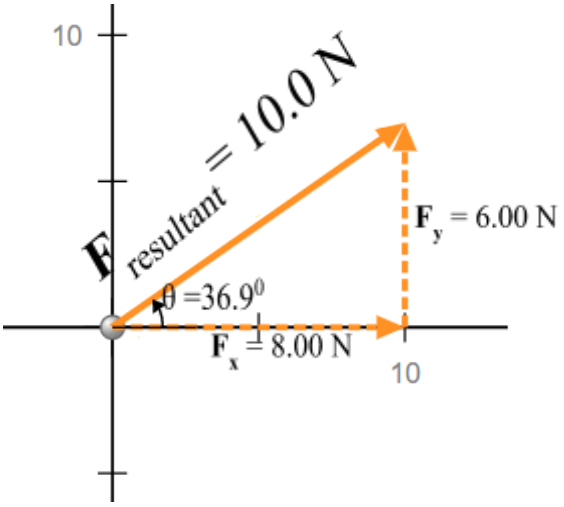


Figure 8. The x- and y- components of the force in fluffy's chain and the resultant vector

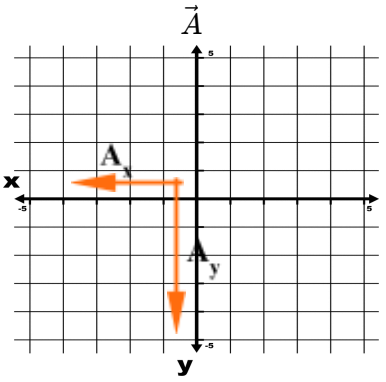
Navigate

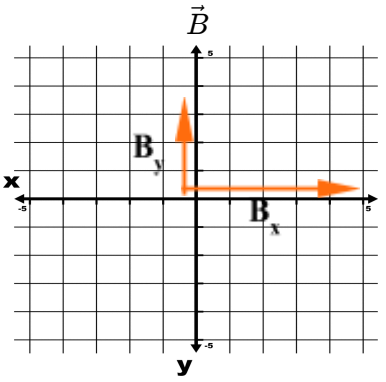
GRADED

Write your complete and organized solution on a whole sheet of paper. Scan it or take a clear photo. Follow your teacher's instructions regarding submission. All items will be graded.

8

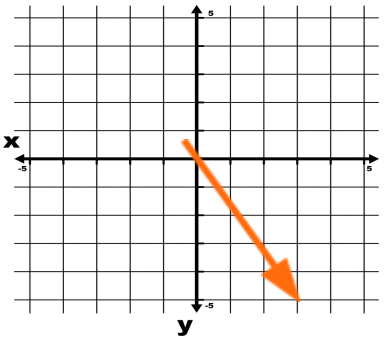
1. Two vectors $\overline{A}$ and $\overline{B}$, have vector components that are shown (to the same scale) in the drawing. The resultant vector is labeled relative to the x-axis. (i) Which drawing shows the vector sum of $\overline{A}_x + \overline{A}_y$? (ii) Which drawing shows the vector sum of $\overline{B}_x + \overline{B}_y$?



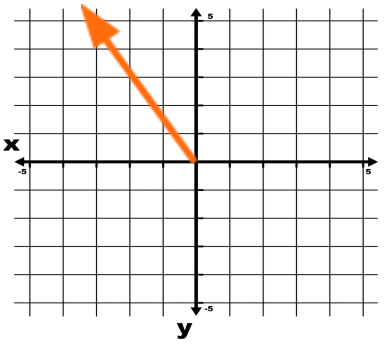


Choices:

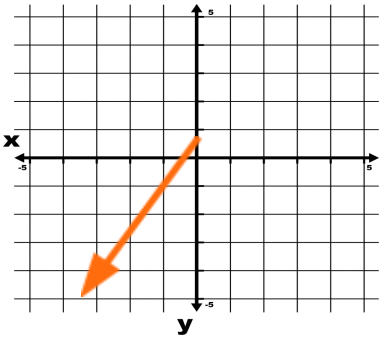
(A)



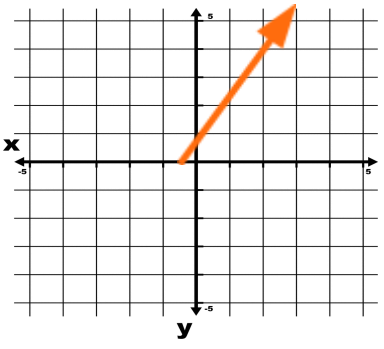
(B)

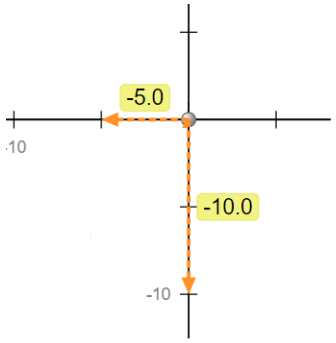
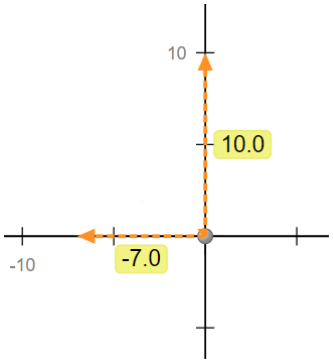


(C)



(D)



	For the next two items, sketch vector $\overline{R}$ and compute for its magnitude and direction given its components. 2.  3.  		
Knot 	In summary, We can determine the magnitude and direction of vectors by taking note of the magnitude and direction of its x- and y- components. The **magnitude of a vector** may be determined using the **Pythagorean Theorem,** $$C^2 = A^2 + B^2$$ The ***magnitude*** of vector **A** is computed as, $$A^2 = A_x{}^2 + A_y{}^2$$ The direction of vector **A** is computed as, $$\theta = \tan^{-1}(\frac{A_y}{A_x})$$	1	

References:

1. Giancoli, Douglas C. (2014). *Physics Principles with Applications 7th ed*. United States of America: Pearson Education, Inc.
2. Cutnell, John D. and Johnson, Kenneth W. (2012). *Physics 9th ed*. United States of America: John Wiley & Sons, Inc.
3. Vector components. Retrieved July 12, 2020 from https://www.physicsclassroom.com/class/vectors/Lesson-1/Vector-Addition

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