Subject Code	PHY1	**Physics 1**
Module Code	4.0	**Vectors**
Lesson Code	4.7	**Solving Word Problems in Vector Addition**
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: • apply the component method in solving word problems.	1	
HOOK 	In the previous lesson, you have learned how to add vectors using the component method. You have learned that when using the component method, you should follow these three simple steps: 1. Get the x- and y-components of each of the given vectors, and add all x- and y-components, respectively. 2. Get the magnitude of the resultant vector by applying the Pythagorean theorem, that is: $R = \sqrt{R_x^2 + R_y^2}$ (Equation 1) 3. Determine the direction of the resultant by using the following equation: $\theta = \tan^{-1}(R_y/R_x)$ (Equation 2) Are you now ready to apply the component method in solving real-life situations?	2	
IGNITE 	Let us solve some word problems involving vector addition. In physics, your skill in vector addition is very important especially when determining net displacements, net forces, and the like. When solving word problems, it is very important that you provide systematic and clear solutions. In the case of vector addition, it is best for you to draw the given vectors so that it will be easier to get the components of the vectors and proceed with vector addition using the analytical or component method. Let us take a look at the following examples.	14	

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

Example 1
Jade wanted to visit her teacher in school. From their house, she walked 30 m, east; then, 35 m, north; and finally, 50 m, 50^0, north of east where she reached the school's main gate. What was Jade's total displacement?

To understand the problem better, let us draw the series of displacements made by Jade.

Recall that displacement refers to the straight-line distance between the initial and final positions. Hence, the total displacement of Jade pertains to the resultant vector of her three displacements.

We will now use the component method to answer the problem.

Step 1:

Displacement	x-component	y-component
d1	$d1_x = 30$ m	$d1_y = 0$
d2	$d2_x = 0$	$d2_y = 35$ m
d3	$d3_x = 50 \cos 50^0$ $= 32.14$ m	$d3_y = 50 \sin 50^0$ $= 38.30$ m
Total (dT)	$dT_x = 30 + 32.14$ $= 62.14$ m	$dT_y = 35 + 38.30$ $= 73.30$ m

Step 2:

$$dT = \sqrt{dTx^2 + dTy^2}$$

$$= \sqrt{(62.14)^2 + (73.30)^2}$$

= 96.10 m

Step 3:

$$\theta = \tan^{-1}(R_y/R_x)$$

$$= \tan^{-1}(73.30/62.14)$$

$$= 49.71^0$$

Final Answer: The total displacement of Jade from their house to their school is 96 m, 50^0 north of east.

Example 2

Jerry is pulling a box as shown below. He is exerting a 100-N amount of force which is directed along the rope. However, aside from the force he is exerting, there are other forces acting on the box. These include the gravitational force which is 1470 N, directed downward; the normal force which is 1470 N, directed upward; and a 12.5-N friction, directed opposite the horizontal motion of the box. What is the net force acting on the box?

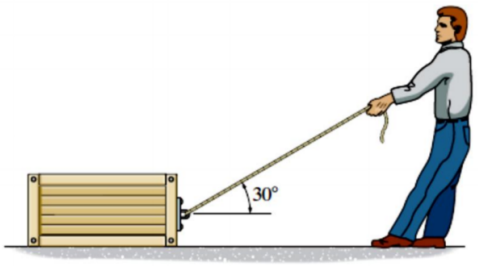
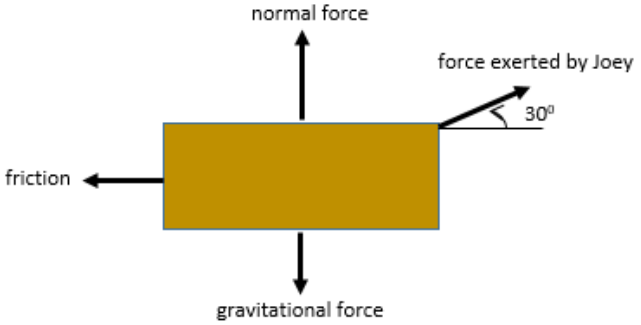


Image retrieved from:
https://www.chegg.com/homework-help/questions-and-answers/worker-moving-crate-pulling-shown-coefficient-static-friction-150-kg-crate-ground-025---de-q9910617

Let us draw the different forces acting on the box.



We will now use the component method to answer the problem. For the purpose of notations, we will use $F_{applied}$ for the force applied by Jerry; F_{fric} will refer to friction; F_{grav} for gravitational force; F_{norm} for the normal force; and F_T for the

net force.

Step 1:

Displacement	x-component	y-component
$F_{applied}$	$F_{applied_x} = 100 \cos 30^0 = 86.60$ N	$F_{applied_y} = 100 \sin 30^0 = 50$ N
F_{fric}	$F_{fric_x} = -12.5$ N	$F_{fric_y} = 0$
F_{grav}	$F_{grav_x} = 0$	$F_{grav_y} = -1470$ N
F_{norm}	$F_{norm_X} = 0$	$F_{norm_y} = 1470$ N
F_T	$F_{T_x} = 74.10$ N	$F_{T_y} = 50$ N

Step 2:

$$F_T = \sqrt{(74.10)^2 + (50)^2}$$

$$= 89.39 \text{ N}$$

Step 3:

$$\Theta = \tan^{-1}(50/74.10)$$
$$= 34.01^0$$

Final Answer: The net force acting on the box is 89.4 N, 34.0^0 above the horizontal.

NAVIGATE

It's your turn to practice solving word problems involving vector addition. I have placed the answers below the items so that you could check whether or not you got the correct answer.

6

1. In relation to the COVID-19 pandemic, a relief operation was undertaken at Barangay Pag-asa. Starting from the barangay hall, the volunteers had their house-to-house distribution by moving 2 blocks north, 3 blocks east, and 4 blocks 35^0 south of west. What is the volunteer's total displacement?

2. Three guys are pulling one end of a seesaw. One of them exerts 50 N, 60^0 from the +x-axis while the other two exerts 60 N, -30^0 and 75 N, 270^0, both angles measured from the +x-axis, respectively. Find the magnitude and direction of the resultant of these forces.

Answers:

1. *The volunteers are 0.4 block, 46^0 south of west from the barangay hall.*

	2. *The net force on one end of the seesaw is 99 N, 39^0 clockwise from the +x-axis.*		
KNOT 	In summary, to solve word problems involving vector addition, all you have to do is to make a drawing of the given vectors and follow the steps in vector addition using the component method. Now it is time to assess what you have learned. Write your answers with complete solutions on a clean sheet of paper. Follow your teacher's instructions regarding submission. All items will be graded. 1. Julianne went to a restaurant to have a taste of her favorite fried chicken and spaghetti. She drove 2 km, east and then 8.5 km, northeast. What is Julianne's displacement from her origin? 2. Joey and his friends are pushing a piece of driftwood which they will be using in their landscaping project. They pushed the wood by applying the following forces: Joey: 5 N, north; Friend 1: 2.2, west; and Friend 2: 3.86 N, 55^0 north of west. What is the net force applied by Jerry and his friends on the wood?	7	

References:

1. Lumen Learning. (n.d.). Vector addition and subtraction: analytical methods. https://courses.lumenlearning.com/physics/chapter/test-vector-addition-and-subtraction-analytical-methods/
2. Giancoli, D. C. (2007). *Physics: Principles with Applications.* (6th edition). Pearson Education, Inc.
3. Henderson, T. (1996-2020). The Physics Classroom. Component Method of Vector Addition. https://www.physicsclassroom.com/class/vectors/Lesson-1/Component-Addition
4. Image of a man pulling a box retrieved from https://www.chegg.com/homework-help/questions-and-answers/worker-moving-crate-pulling-shown-coefficient-static-friction-150-kg-crate-ground-025---de-q9910617.
5. Image of school in IGNITE retrieved from https://www.dreamstime.com/stock-illustration-cartoon-school-building-green-yard-vector-illustration-isolated-white-image63350542.
6. Image of house in IGNITE retried from http://clipartbarn.com/clipart-house_39826/.
7. Image of a girl in IGNITE modified from http://www.oogazone.com/2019/unique-student-clip-art-pictures/.

Prepared by: Mary Grace R. Navarro	Reviewed by: Jacquelyn O. Mirasol
Position: SST V	Position: SST IV
Campus: Ilocos Region Campus	Campus: Ilocos Region Campus