

# AP Physics 1 Summer Assignment

## Rumson Fair Haven Regional High School

- *All summer work is dependent upon your finalized schedule*
- *Attendance at this meeting does NOT ensure your enrollment in this course*

Vector addition and subtraction are skills that you will need to be successful in AP Physics 1. While the idea of vector addition and subtraction might sound new, the process you will use is simply an application of trigonometry combined with simple addition and subtraction and the Pythagorean Theorem.

The purpose of this assignment is as follows:

- To provide an impetus to review basic trig, specifically sine, cosine, and inverse tangent.
- To provide a model to follow to break vectors into x-components and y-components
- To provide a model to follow to resolve components into resultant vectors.
- To provide enough practice with these skills that they seem familiar as we begin to apply them in September

These concepts may seem foreign at this time, but it is more important, at this time, that you demonstrate to yourselves and your instructor that you have the ability to apply the skill even if you might not quite understand the ideas that they support.

Should you find yourself feeling lost, or needing a review of some of the math skills required, you may visit Ms. Foster's AP Physics page through the RFH website. There you will find a page with assorted videos and tutorials that might be useful. If you are taking Mr. Huebner's summer AP Physics 1 Prep. course, you will be given support in completing this assignment, make sure you bring it with you!

Please make sure you give this assignment the time that it requires; a lack of familiarity with these skills can put you at a serious disadvantage as the course moves very quickly. Most students do their work on a separate sheet(s) of paper. Regardless of the format you choose, you must show all of your work, meaning all of the steps, to receive full credit for the assignment.

These assignments will be graded as a major assessment and collected within the first 2 weeks of the start of the school year.

***\*\*Make sure your calculator is in degree mode otherwise all of your answers will be incorrect\*\****

**Part I: These are the steps that you will be asked to follow:**

**Vector Addition & Subtraction Steps**

Step 1. Draw a diagram.

Step 2. Use these equations to break apart your vectors into their x & y components.

$$V_x = V\cos\theta$$

$$V_y = V\sin\theta$$

Step 3.

- a. Choose a positive direction for both the x & y directions (usually up and to the right).
- b. Assign signs to the x & y components you already calculated.

Step 4. Add the x-components together from all of the vectors to find the overall x component.

Step 5. Add the y-components together from all of the vectors to find the overall y-component.

Step 6. Use Pythagorean Theorem to combine the overall x & y components into the resultant.

Step 7. Use the equation  $\theta = \tan^{-1}\left(\frac{y\text{-component}}{x\text{-component}}\right)$  to find the angle of the resultant.

***Make all numbers positive in the  $\tan^{-1}$  equation, no matter what their sign.***

Step 8. Use the signs of the x-component and y-component to draw a diagram of the resultant and report the direction of the angle relative to either the +x-axis or the -x-axis or relative to a compass direction.

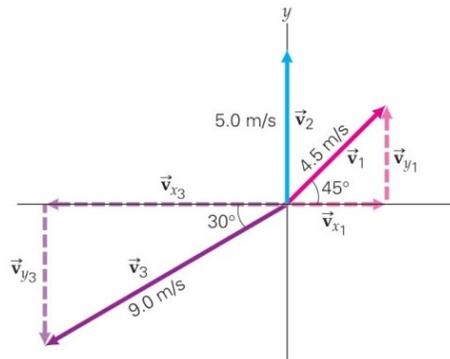
**Part II: Here you will find an example of how the steps in Part I are applied. Using this as a model, you should be able to solve the problems that follow.**

**Example Problem:**

Add the 3 vectors 4.5 m/s at an angle of  $45^\circ$  above the positive x-axis, 5.0 m/s at an angle of  $90^\circ$  to the positive x-axis, and 9.0 m/s at an angle of  $30^\circ$  below the negative x-axis.

**Step 1.**

Draw a diagram:



**Step 2.**

Vector 1 components ( $V_1 = 4.5$  m/s at 45 degrees above the +x axis):

$$\begin{aligned} V_{x1} &= V_1 \cos \Theta & V_{y1} &= V_1 \sin \Theta \\ V_{x1} &= 4.5 \cos(45^\circ) & V_{y1} &= 4.5 \sin(45^\circ) \\ V_{x1} &= 3.18 \text{ m/s} & V_{y1} &= 3.18 \text{ m/s} \end{aligned}$$

Vector 2 components ( $V_2 = 5.0$  m/s at 90 degrees above the +x axis):

$$\begin{aligned} V_{x2} &= V_2 \cos \Theta & V_{y2} &= V_2 \sin \Theta \\ V_{x2} &= 5.0 \cos(90^\circ) & V_{y2} &= 5.0 \sin(90^\circ) \\ V_{x2} &= 0 \text{ m/s} & V_{y2} &= 5.0 \text{ m/s} \end{aligned}$$

Vector 3 components ( $V_3 = 9.0$  m/s at 30 degrees below the -x axis):

$$\begin{aligned} V_{x3} &= V_3 \cos \Theta & V_{y3} &= V_3 \sin \Theta \\ V_{x3} &= 9.0 \cos(30^\circ) & V_{y3} &= 9.0 \sin(30^\circ) \\ V_{x3} &= 7.79 \text{ m/s} & V_{y3} &= 4.50 \text{ m/s} \end{aligned}$$

**Step 3.**

- Choose positive and negative directions: To the right is positive and up is positive.
- Assign signs to your components:

Vector 1 is in Quadrant 1, so  $V_{x1} = 3.18$  m/s and  $V_{y1} = 3.18$  m/s.

Vector 2 is in the positive y-direction, so  $V_{x2} = 0$  m/s and  $V_{y2} = 5.0$  m/s.

Vector 3 is in Quadrant 3, so  $V_{x3} = -7.79$  m/s and  $V_{y3} = -4.50$  m/s

**Step 4.**

Add your x-components...

$$V_{x1} + V_{x2} + V_{x3} = V_x,$$

so

$$3.18 \text{ m/s} + 0 \text{ m/s} + -7.79 \text{ m/s} = V_x = -4.61 \text{ m/s}.$$

**Step 5.**

...and your y-components.

$$V_{y1} + V_{y2} + V_{y3} = V_y,$$

so

$$3.18 \text{ m/s} + 5.0 \text{ m/s} + -4.5 \text{ m/s} = V_y = 3.68 \text{ m/s}.$$

**Step 6.**

Pythagorean Theorem:

$$\text{Final vector} = \sqrt{-4.61^2 + 3.68^2} = 5.90 \text{ m/s}$$

**Step 7.**

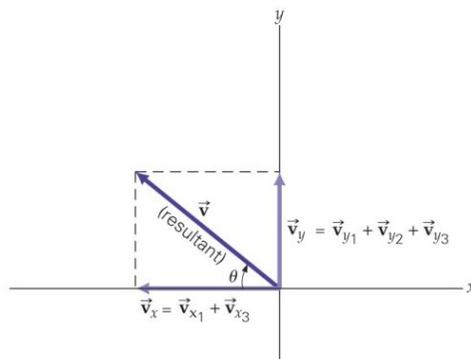
Angle of the resultant:

$$\theta = \tan^{-1}\left(\frac{y\text{-component}}{x\text{-component}}\right) = \tan^{-1}\left(\frac{3.68}{-4.61}\right) = 38.6^\circ$$

*Remember: Make all numbers positive in the  $\tan^{-1}$  equation, no matter what their sign.*

**Step 8.**

Since the overall x-component is negative and the overall y-component is positive, the resultant is in Quadrant 2. Draw a diagram and report the direction as  $38.6^\circ$  above the negative x-axis.



**Part III: Here you will find an opportunity to practice using the Sin and Cos functions. You are only following steps 1, 2, and 3.**

**Vector Component Practice-**

Break apart each of the following vectors into their x & y components and assign the correct sign for each component:

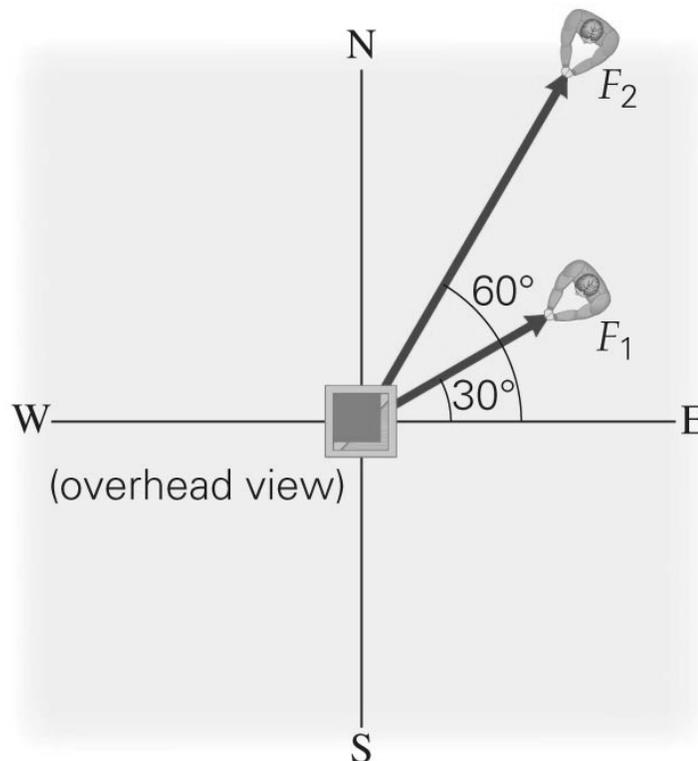
1. 16 m/s at an angle of  $25^\circ$  above the positive x-axis.
2. 24 m at an angle of  $62^\circ$  below the negative x-axis.
3.  $52 \text{ m/s}^2$  at an angle of  $38^\circ$  below the positive x-axis.
4. 6.0 N at an angle of  $48^\circ$  above the negative x-axis.
5.  $15 \text{ kg}\cdot\text{m/s}$  at an angle of  $30^\circ$  below the negative x-axis.
6. 250 m/s at an angle of  $55^\circ$  above the positive x-axis.
7.  $1.2 \times 10^7 \text{ m}$  at an angle of  $20^\circ$  below the negative x-axis.
8.  $6.5 \times 10^{-5} \text{ m}$  at an angle of  $34^\circ$  above the positive x-axis.
9.  $4.3 \times 10^3 \text{ N}$  at an angle of  $45^\circ$  below the positive x-axis.
10.  $3.7 \text{ m/s}^2$  at an angle of  $78^\circ$  above the negative x-axis.

**Part IV: Here you will find an opportunity to practice all of the steps.**

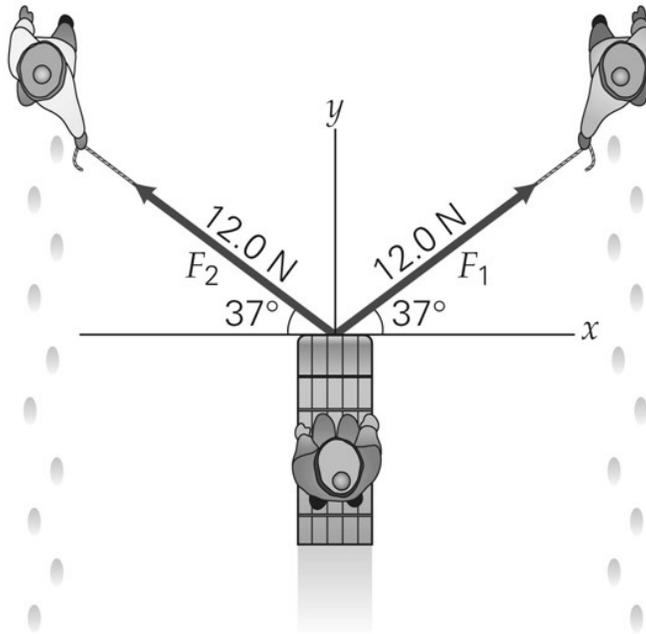
**Vector Addition Practice –**

Add the following vectors together:

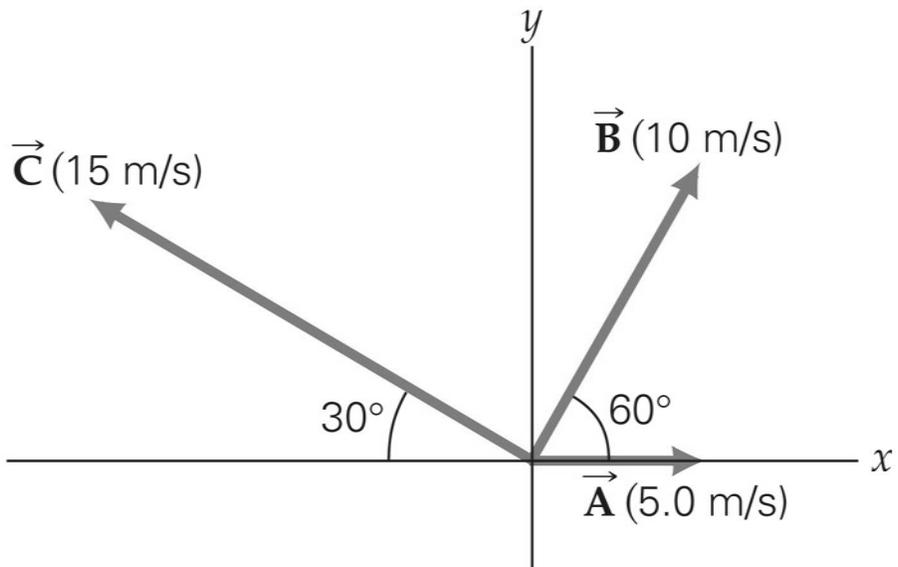
1.  $F_1 = 50.0 \text{ N}$   
 $F_2 = 100.0 \text{ N}$



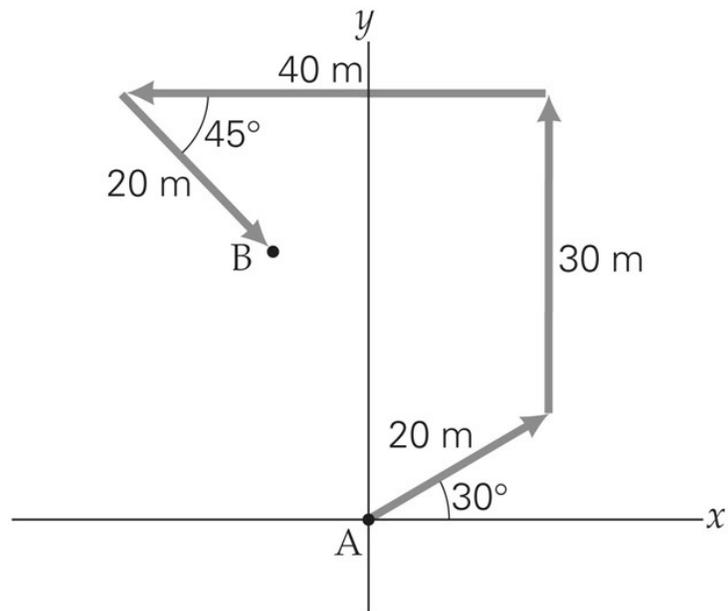
2.



3.



4.



5.  $F_1 = 5.5 \text{ N}$   
 $F_2 = 3.5 \text{ N}$

