PHYSICS LABS

Name ……nandita…………………………………………… **Section #** ……….3……………

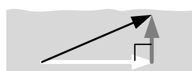
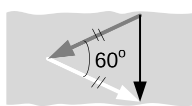
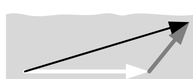
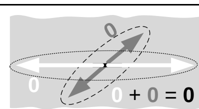
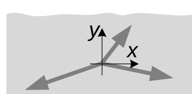
Vector Addition

Objective

Using on-line software, practice different ways of adding vectors (using “tip-to-taile”/”head-to-tail”/”triangle” method).

Overview of different mathematical methods of vector addition

Look at the vectors in the diagram and decide what mathematical method to use for finding their sum. Although it is always possible to use vector components, application of graphical methods – “tip-to-tail/triangle” or “parallelogram” – when possible takes much less time to find the magnitude of the resultant vector and allows easier determination and description of its direction (as in the situation when this vector makes an obtuse angle with would be chosen positive direction of the *x*-axis). Here are some guidelines for making the choice:

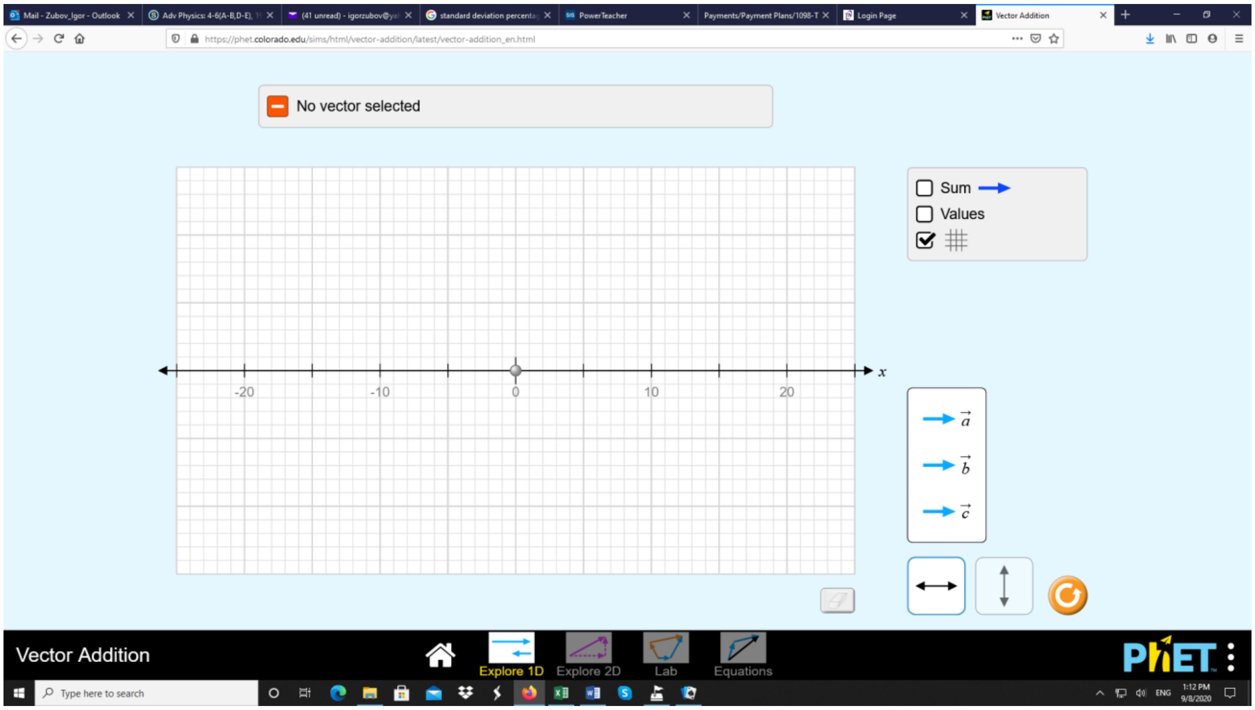
Situation	***Suggested method***
All vectors are along *one line* 	“Tip-to-tail”.
2 vectors make up a *right* triangle 	Method 1: Graphical addition + Pythagorean theorem and trigonometric functions. Method 2: Components of vectors in chosen “x” and “y” directions.
2 vectors make up a *special* triangle or parallelogram 	Method 1: Properties of the special geometric figures. Method 2: Components of vectors in chosen “x” and “y” directions. Method 3: Theorems of cosine and sine.
2 vectors make up a triangle or a parallelogram without special properties 	Method 1: Components of vectors in chosen “x” and “y” directions. Method 2: Theorems of cosine and sine.
3 or more vectors with *pair(s)* of vectors making up a *special* shape 	Method 1: Graphical method for the pair(s) and addition of the results. Method 2: Components of vectors in chosen “x” and “y” directions.
3 or more vectors with different arbitrary magnitudes and directions 	Components of vectors in chosen “x” and “y” directions.

Procedure

Go to **https://phet.colorado.edu/sims/html/vector-addition/latest/vector-addition_en.html** .

Part 1: Vectors along same line.

Select “Explore 1D” icon. Do NOT check the “Sum” checkbox for now.



1. Drag vector ***a*** to the grid so that it starts at 0 and points to the right. Change its magnitude to any (whole) number between 0 and 10.

Here, bold italic letters stand for vectors and italic for magnitudes.

2. Drag vector ***b*** to any place on the grid so that it points to the right. Change its magnitude to any (whole) number between 0 and 10 but different from *a*. Record the magnitudes here:

|*a*| or *a* = …5……….. , **|*b*|** or *b* =……6……. .

3. Drag ***b*** so that it starts at/its “tail” is at the tip/”head” of ***a***. Check the “Sum” box, click on the dark blue arrow representing the sum ***s*** = ***a*** + ***b*** (here, you will need to drag at least one of the two addend vectors away from where they are: ***s*** is under light blue arrows), and look at and write down the magnitude of the sum

s = …11……. .

Look at the magnitudes and directions of the three vectors and state, how to find the magnitude and direction of the sum of two collinear vectors pointing in *same direction*, sometimes called *co-parallel* vectors:

The direction can be found by looking at the angle formed by the vectors and the magnitude can be found by adding the two magnitudes if the vector.

4. Uncheck the “Sum” box, change the direction of ***b*** to the opposite without changing its magnitude.

5. Drag ***b*** so that it starts at/its "tail" is at the tip/"head" of ***a***. Check the "Sum" box, click on the dark blue arrow representing the sum ***s*** = ***a*** + ***b*** (here, you will need to drag at least one of the two addend vectors away from where they are: ***s*** is under light blue arrows), and look at and write down the magnitude of the sum

s = …………11….. .

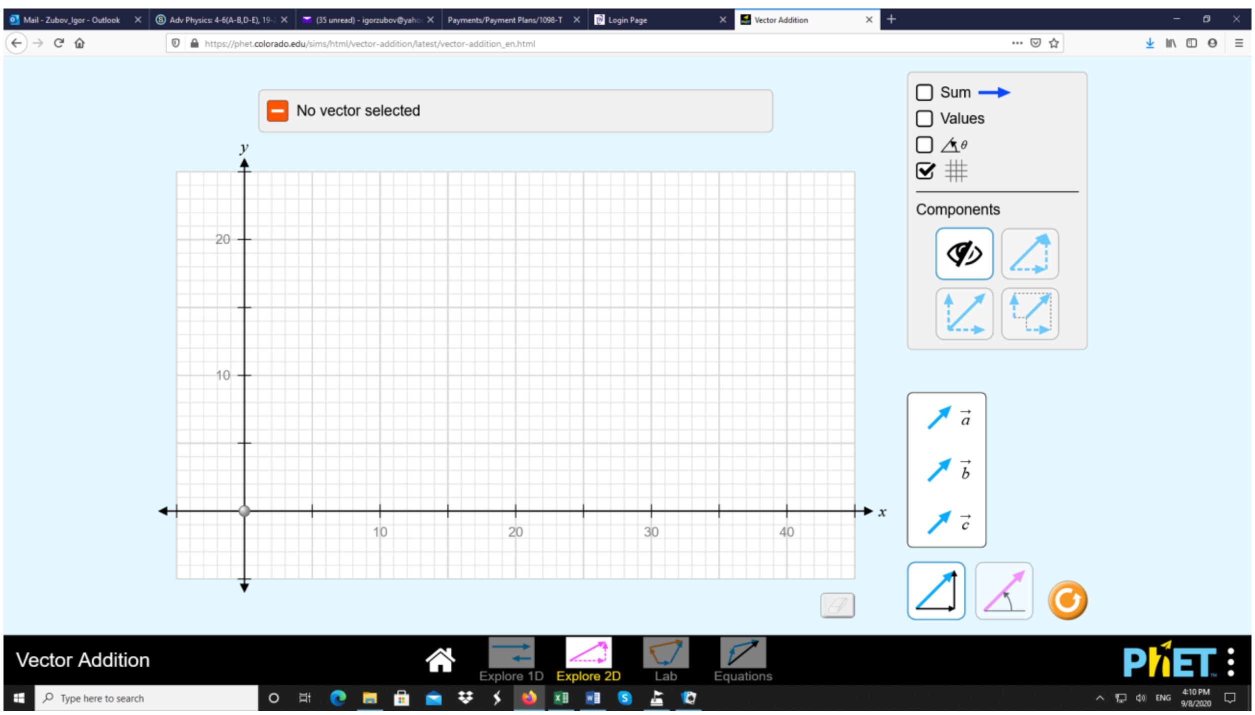
Look at the magnitudes and directions of the three vectors and state, how to find the magnitude and direction of the sum of two collinear vectors pointing in *opposite directions*, sometimes called *anti-parallel* vectors (it might help to refer to the two vectors as greater and smaller):

………you can still find the sum by adding up the magnitudes of all the vectors.……………………..

…………………………………………………………………………………………...

Part 2: Perpendicular vectors.

Select "Explore 2D" icon. Do NOT check the "Sum" checkbox for now.

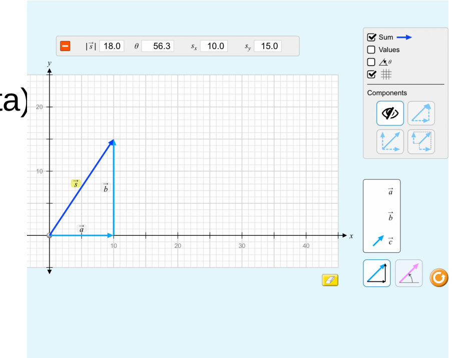


1. Drag vector ***a*** to the grid so that it starts at 0 and direct it to the right along *x*-axis. Change its magnitude to any (whole) number between 0 and 40.

2. Drag vector ***b*** to any place on the grid so that it points up along y-axis. Change its magnitude to any (whole) number between 0 and 20, same as *a* or different. Record the magnitudes here:

|*a*| or *a* = …10…….. , **|*b*|** or *b* =…15…….. .

3. Drag ***b*** so that it starts at/its "tail" is at the tip/"head" of ***a***. Check the "Sum" box, click on the dark blue arrow representing the sum ***s*** = ***a*** + ***b*** and drag it to start from 0. Look



at and write down the magnitude of the sum and angle ϑ (theta) direction of *x*-axis:

s = ……18…. , ϑ = ………56.3….. .

Make a screenshot and paste it here:

{SPACE FOR THE SCREENSHOT}

4. Use the <u>right triangle</u> formed by the three vectors to determine *s* and ϑ. Show your work in the space below:

s^2= a^2+b^2

s=18

$\theta = \sin^{-1}x$

theta = 56.3 degrees

5. Use components of ***a*** and ***b*** to find components of ***s*** and then determine *s* and ϑ. Show your work in the space below:

s^2= a^2+b^2

s=18

$\theta = \sin^{-1}x$

theta = 56.3 degrees

6. State how the results obtained above in (3) – (5) compare to each other and which of the methods used in (4) and (5) is easier/shorter/requires less caclulations:

……..3 involves a graph which can be inaccessible so it may be easier to…………………………
use an equation with sohcahtoa

Part 3: Vectors at an arbitrary angle.

Continue with the "Explore 2D" icon.

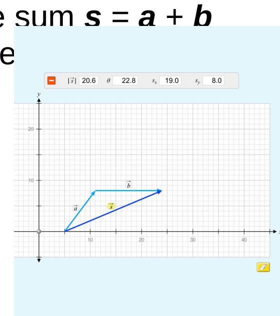
1. Drag vector ***a*** to the grid so that it starts anywhere other than 0 and at an acute angle with positive direction of *x*-axis. Change its magnitude to any (whole) number between 10 and 20.

2. Drag vector ***b*** to any place on the grid so that it starts at the tip of ***a***. Change its magnitude to any (whole) number between 0 and 20, same as *a* or different. Change its direction that it makes any angle with ***a*** except 0º and 180º.Record the magnitudes and angles the vectors make with positive direction of *x*-axis here:

a = ……10…... , ϑ_a = ….53.1..   ,   *b* =.13……….. , ϑ_b = …53.1……. .

3. Check the "Sum" box, click on the dark blue arrow representing the sum ***s*** = ***a*** + ***b*** and drag it to start from the beginning of ***a***. Look at and write down the sum and angle ϑ (theta) it makes with positive direction of *x*-axis:

s = ….20.6…. , ϑ = ……22.8……… .



Make a screenshot and paste it here:

{SPACE FOR THE SCREENSHOT}

4. Use the rules/laws of <u>cosine</u> and <u>sine</u> for the <u>triangle</u> formed by the three vectors to determine *s* and ϑ. Show your work in the space below:

angle a + angle b+ angle s = 180 degrees

53.1 + 22.8 + angle s = 180

angle s= 104.1 degrees

5. Use components of ***a*** and ***b*** to find components of ***s*** and then determine *s* and ϑ. Show your work in the space below:

angle a + angle b+ angle s = 180 degrees

53.1 + 22.8 + angle s = 180

angle s= 104.1 degrees

6. State how the results obtained above in (3) – (5) compare to each other.

the difference is the use of graphing verses the use of equations and calculations

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<u>Question</u>

Looking at all results above, answer in terms of Always, Sometimes, or Never if the magnitude of the sum of two vectors is equal to the sum of their magnituded.

Sometimes

Elaborate on when it is true:

this is true when the angles formed by the vectors is 180 degrees

……………………………………………………………………………………………