PHY111

Lab Assignment: 01

Vectors and Vector Operations

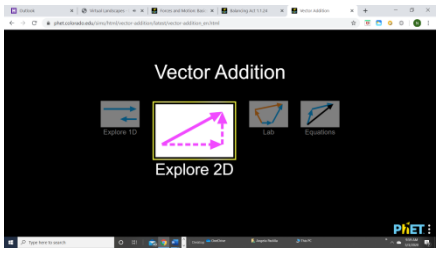
Part A: Simulation Introduction

We will be doing the vector simulation using the PhET interactive simulation project at the University of Colorado Boulder. It provides free interactive math and science simulations that engage students through an intuitive, game-like environment where students learn through exploration and discovery. You can check out their website here: https://phet.colorado.edu/

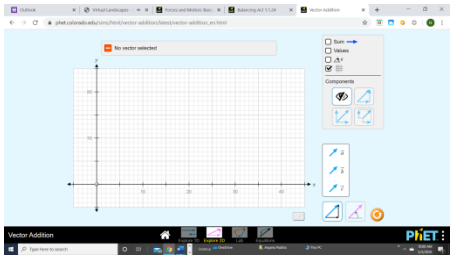
Check out their vector simulation for the first lab and play with it.

1. Open the vector simulation:

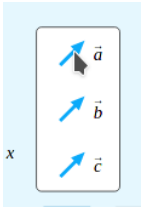
   https://phet.colorado.edu/sims/html/vector-addition/latest/vector-addition_en.html



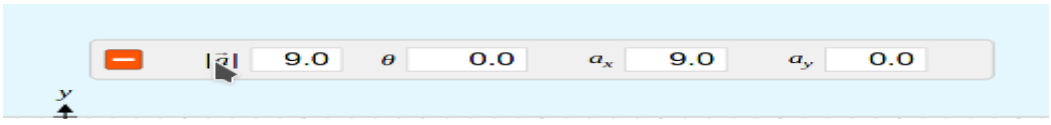
2. Open Explore 2D by clicking on the icon above. Your screen will open the simulation like the one in the figure below.



3. You can add a vector by clicking and dragging a vector from the lower right panel on your screen.



4. Click on ay vector in the plot and look at the chart at the top of the page. Here is an explanation of what each number represents:



a. **|a|** represents the length of the arrow. This is usually called the **magnitude** of the vector.
b. **Θ** represents the direction the arrow points. This is simply called the **direction** of the vector. The magnitude And direction will completely define a vector.
c. a_x is called the **X-component** of the vector. This is the length of the vector in X-direction only.
d. a_y is called the **Y-component** of the vector. This is the length of the vector in the Y-direction only.

5. You can adjust the direction and length of the vector by click-dragging the arrow head. Play with this until you are comfortable.

Part B: Triangle Vector

TASK 1:

Drag out the vector **a**, and move it until the tail is located at the origin. Click on the head of the vector, and drag it until it is completely horizontal, points to the right, and has a magnitude (**|a|**) of 20.

(**Tips:** If you want to start over, click **Erase button** )

Q1: For the first vector you dragged out, fill in the chart at the below:

|a|	Θ	a_x	a_y

Take a screenshot of your screen and save it as ID_TASK1_LAB1

For example: 21115002_TASK1_LAB1 (Make sure you save it with your ID)

TASK 2:

Now drag out the second vector **b** and place its tail at the head of the first, adjust this second vector until it points vertically upward and has a length of 10.

Q2: Fill in the table for the second vector here:

|b|	Θ	b_x	b_y

Take a screenshot of your screen and save it as ID_TASK2_LAB1

See these diagrams to see how to draw the second vector if you are having trouble

TASK 3:

If you had started from the origin and walked in two parts, horizontal distance of 20 unit (vector **a**) and then vertical distance of 10 units(vector **b**) your DISPLACEMENT is the hypotenuse of the triangle , and your current displacement is 22.4 units away from the origin.

You can show this by clicking the button that says **Sum**. A blue vector should pop up. This represents the vector sum, or **resultant**, of the first two arrows.

Drag this vector over so that the tail is at the origin, and use it to form the hypotenuse of a right triangle. Notice that the head of this resultant vector(s) ends exactly where the second vector ends.

Q3: Fill in the table for the resultant vector (s) here:

|s|	Θ	s_x	s_y

Take a screenshot of your screen and save it as ID_TASK3_LAB1

Q4: Compare the x component and y component (s_x and s_y) values for the resultant vector (s) to the magnitude of the first two vector (|a| and |b|). What do you notice about these values?

Ans:

Part C: Single Vector, Magnitude 22.4

TASK4:

Create a vector **|a|** with an a_x of 20 and a_y of 10.

Q5: Fill in the chart for this vector here:

|a|	Θ	a_x	a_y

Take a screenshot of your screen and save it as ID_TASK4_LAB1

Q6: Compare the chart values of this vector to those of the resultant vector (|s|) from Q3. How do these values compare?

Ans:

TASK5:

Now, click the **style 2**  button on the "Component Display" menu. This is a way to visualize any vectors as a sum of horizontal and vertical components.

Adjust this **a** vector until it has an a_x value of 10 and a_y value of 20.
Take a screenshot of your screen and save it as ID_TASK5_LAB1

Q7: Fill in the chart for this vector:

|a|	Θ	a_x	a_y

Q8: Has the <u>magnitude</u> (that is, |a|) of this vector changed, compared Q5? If so, how?

Ans:

Q9: Has the <u>direction</u> (that is, θ) of this vector changed, compared to Q5? If so, how?

Ans:

Looking at this vector **a**, it is easy to imagine a right triangle, made form, a_x, a_y and **|a|.** In this case, **|a|** would be hypotenuse, and a_x & a_y, would be the legs.

Q10: Show, using the Pythagorean Theorem, that $|a|^2 = a_x^2 + a_y^2$ (You will get a very close value, not an exact value !! The result does not have to be exact. Approximations are acceptable)

Ans:

Q11: Show, using SOHCAHTOA , that the a_x component = $|a|\cos(\theta)$. You will get a very close value, not an exact value !! The result does not have to be exact. Approximations are acceptable)

Ans:

Q12: Show, using SOHCAHTOA, that the a_y component = $|a|\sin(\theta)$. (You will get a very close value, not an exact value !! The result does not have to be exact. Approximations are acceptable)

Ans:

Part D : Multiple Vectors

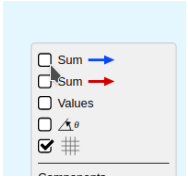
For this section, we need to switch to the lab tab of vector simulation.

Click on the home tab  at the bottom center of the screen.Click on the Lab tab, 

, to open lab simulation.

TASK6:

Now, add a blue vector onto the graph by clicking and dragging a blue vector from the right lower panel.  . Create 4 vectors, as shown below. The length of each horizontal vectors should be 10 , and the length of the vertical vectors should be 5.

Click on the **Sum** button (blue arrow) 

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Take a screenshot of your screen and save it as ID_TASK6_LAB1

Q13: Fill in the chart for this resultant vector.

|s|	Θ	s_x	s_y

Q14: How do the |s| compare to the |s| value from Q3?

Ans:

TASK7:

Clear all vector on screen and construct the following 4 vectors representing someone on four hikes:

1. $|v| = 30, \theta = 0^{\circ}$
2. $|v| = 10, \theta = 90^{\circ}$
3. $|v| = 10, \theta = 180^{\circ}$
4. $|v| = 10, \theta = 90^{\circ}$

Take a screenshot of your screen and save it as ID_TASK7_LAB1

Q15: What is the sum(or resultant) of these vectors?

$\|s\|$	Θ	s_x	s_y

Q16: So what is the displacement walked?

Ans:

Q17: What is the distance walked?

Ans:

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