

# Vectors

Name:

Group Members:

Date:

TA's Name:

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**Apparatus:** Computer, ruler, protractor

## Objectives:

- 1) To find components of vectors from magnitude and direction.
- 2) To find magnitude and direction of vectors from components.
- 3) To add and subtract vectors both graphically and using components.
- 4) To resolve vectors into components with a tilted coordinate system.

## Part A: Vector Addition Phet Simulation

Go to the website: <http://phet.colorado.edu> and click on Play with Simulations.

On the simulation menu on the left, find "Math" and click it. New icons appear on the right side of the screen. Scroll down on the right side until you see "Vector Addition" and click on the icon. The program may take a few minutes to load.

Under Component Display click the circle next to "Style 2" and Check the box next to "Show Grid". These settings will not change for the rest of the activity. Grab a vector and place it on the grid. Play around with the program a bit to get comfortable with it.

Please note that in the simulation "R" represents  $\vec{R}$ .

## Part B: Vector Components

1. Drag a vector into the grid and adjust it to have an angle of about  $60^\circ$ .
  - a. What does  $R_x$  represent?
  - b. What does  $R_y$  represent?
  - c. What does  $\theta$  represent?
  - d. What does  $|R|$  represent?

2. Why does the vector have an arrowhead? What does that arrowhead indicate?

3. Grab the middle of the vector and drag it around the grid.  
As you drag the vector around the grid, does its length change? \_\_\_\_\_

Does its direction change? \_\_\_\_\_

Do  $R_x$  and  $R_y$  change? \_\_\_\_\_

Is it the same vector no matter where it sits if it has the same length and direction? \_\_\_\_\_

4. Reshape your first vector so that it is completely horizontal.

What are the values of  $R_x =$  \_\_\_\_\_  $R_y =$  \_\_\_\_\_

$\theta =$  \_\_\_\_\_  $|R| =$  \_\_\_\_\_

Explain why these values make sense for a horizontal vector.

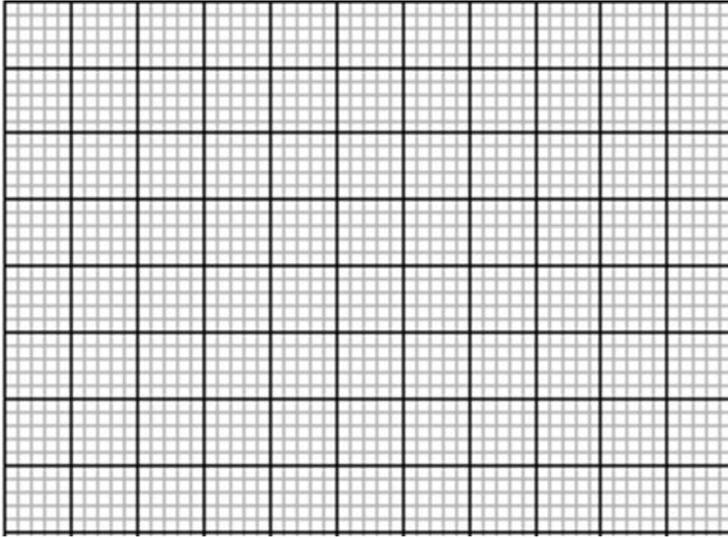
5. Drag another vector into the grid. Reshape it so it is completely vertical. Move that vector so that the tail of the arrow is touching the tip of the other vector on your screen.

What are the values of  $R_x =$  \_\_\_\_\_  $R_y =$  \_\_\_\_\_

$\theta =$  \_\_\_\_\_  $|R| =$  \_\_\_\_\_

Explain why these values make sense for a vertical vector.

6. **Draw what you see on the screen**  
**TO SCALE in the box.**



7. Click on the “Sum” button. A new vector appears on your screen. Drag it so that the tail of the vector is at the tail of the vector from #1.

For the SUM vector find:  $R_x =$  \_\_\_\_\_  $R_y =$  \_\_\_\_\_

$\theta =$  \_\_\_\_\_  $|R| =$  \_\_\_\_\_

Explain why these values make sense for the sum of the first two vectors.

8. Draw the new vector TO SCALE on your drawing in #6. How was the value for  $|R|$  determined?

Calculate it on your own to verify the computer’s result. SHOW ALL YOUR WORK!

9. How was the value for  $\theta$  determined?

Calculate it on your own to verify the computer's result. **SHOW ALL YOUR WORK!**

10. Does the method you used work for all triangles? If not, what special type of triangles does this method work for?

11. Clear all of your vectors. Create a new vector that is not completely horizontal or vertical.

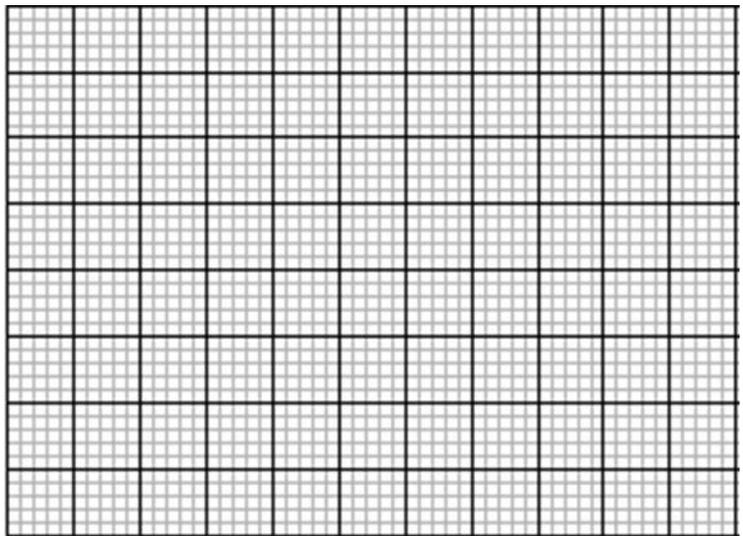
What are the values of  $R_x =$  \_\_\_\_\_  $R_y =$  \_\_\_\_\_

$\theta =$  \_\_\_\_\_  $|R| =$  \_\_\_\_\_

Explain why these values make sense for this vector.

12. What type of triangle is made  
By the vector and its components?

***Draw TO SCALE what you see  
on the computer screen on your  
own page.***



13. Using the value of  $|R|$  and  $R_y$ , how would you calculate  $R_x$ ?

Verify the value of  $R_x$  by calculating it on your own. **SHOW ALL OF YOUR WORK!**

## Part C: Vector Addition

14. Create another vector that is not completely horizontal or completely vertical that points in a quadrant other than the first quadrant (that is, the angle is not between  $0^\circ$  and  $90^\circ$ ).

What are the values of  $R_x =$  \_\_\_\_\_  $R_y =$  \_\_\_\_\_

$\theta =$  \_\_\_\_\_  $|R| =$  \_\_\_\_\_

15. Is either  $R_x$  or  $R_y$  negative? \_\_\_\_\_

Should either or both of them be negative? Why?

16. Drag this second vector so that its tail is touching the tip of the first vector. **Add the second vector to your drawing in Question 12.** Be sure to draw it TO SCALE on the paper. Click the "SUM" button. Move the SUM vector so that its tail is at the tail of the first vector. **Add the SUM vector on the drawing.**

17. For your SUM vector,  
What are the values of  $R_x =$  \_\_\_\_\_  $R_y =$  \_\_\_\_\_

$\theta =$  \_\_\_\_\_  $|R| =$  \_\_\_\_\_

18. For your SUM vector, how was  $R_x$  determined? Calculate it yourself and show your work.

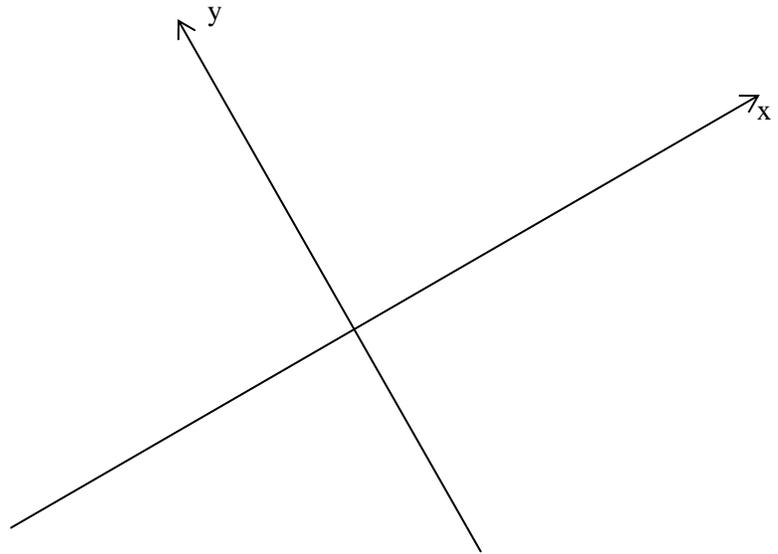
For your SUM vector, how was  $R_y$  determined? Calculate it yourself and show your work.

For your SUM vector, how was  $\theta$  determined? Calculate it yourself and show your work.

For your SUM vector, how was  $|R|$  determined? Calculate it yourself and show your work.

## Part D: Tilted Coordinate System

19. Sometimes it will be convenient to use a coordinate system where the x-axis is aligned with something other than the horizontal direction such as an inclined surface. Here is a coordinate axis that is tilted at  $30^\circ$  with respect to the horizontal.



Draw a vector on this coordinate axis that is 4.0 cm long and points directly to the right (NOT ALONG THE X-AXIS).

Now draw the components of this vector on your drawing and label them as  $R_x$  and  $R_y$ .

For the tilted coordinate system, use the ruler to find the values of

$R_x =$  \_\_\_\_\_  $R_y =$  \_\_\_\_\_ (Make sure to include units)

20. Is  $R_x$  or  $R_y$  negative?

Should either of these be negative?

21. Since the vector is  $30^\circ$  below the x-axis, we use  $\theta = -30^\circ$  for the angle in the given coordinate system. Using  $\theta = -30^\circ$  and  $|R| = 4.0$  cm, calculate the components. Show your work.

$R_x =$  \_\_\_\_\_  $R_y =$  \_\_\_\_\_ (Make sure to include units)

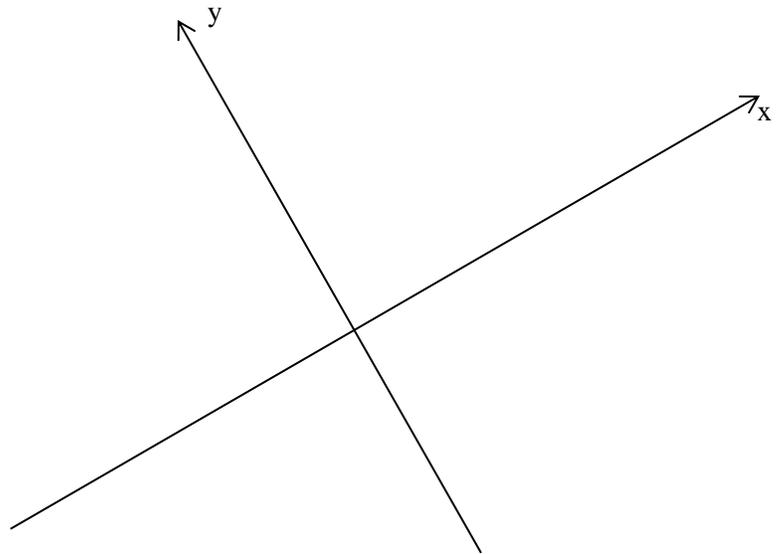
22. Draw a vector on this coordinate axis that is 3.0 cm long and points directly down the page.

Now draw the components of This vector on your drawing and label them as  $R_x$  and  $R_y$ .

For the tilted coordinate system, use the ruler and protractor to find the values of

$R_x =$  \_\_\_\_\_

$R_y =$  \_\_\_\_\_



23. Is either  $R_x$  or  $R_y$  negative?

Should either of these be negative? Why or why not?

24. For this vector with the tilted coordinate system, what are its magnitude and angle?

Use this magnitude and angle to calculate the components. Show your work.

$R_x =$  \_\_\_\_\_       $R_y =$  \_\_\_\_\_      (Make sure to include units)

Are the calculated values close to the measured ones? \_\_\_\_\_

25. Did you use the sine function to calculate  $R_x$ ? \_\_\_\_\_

Did you use the cosine function to calculate  $R_x$ ? \_\_\_\_\_

Why was this correct to use?