Experiment 4 Vector Addition Using Graph Paper, Simulation, and Math

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For parts 1 and 2, we measured out a length of 20 grids on graphing paper and drew them at their respective angles and drew the same line at their respective angle in the phet “vector additions”. We then measured the x and y components from the graph and wrote down the given x and y components from the phet. For parts 3 and 4, we drew each component attaching the head of one to the tail of another for both the graph and the phet. We then drew a line from the origin to the end of the various components to measure the angle and length for the graph and used the sum function for the phet to get the magnitudes and resultants. we calculated the x and y components using the equations “x=h\*cosφ” and “y= h\*sinφ” where h is the length of the hypotenuse and calculated the resultant x and y components for parts 3 and 4 by adding all the components together. To calculate magnitude, we used the equation “sqrt(x2+y2)” and to calculate the angle we used the equation “tan-1(y/x)”. In every case, the simulation method had either an equal or lower percent error compared to the graphical method.

**Results**

Each of the four parts are separate from each other, but they share the 3 different methods to determine their results. For each of the four parts, make a comparison of the graphical method to the mathematical, and a comparison of the simulation method to the mathematical, using the percent error equation.

For all the percent error calculations, the equation will be used where actual will be either graphical or simulation and expected will be mathematical. The actual calculations will not actually be shown but the calculated percent error will.

**Part 1**: The x components were both similar to the calculated value, but simulation was closer by far, while the y components were both equal to the calculated value to two decimal points.  
Graphical  
X: 1.04%  
Y: 0%  
Simulation  
X: 0.115%  
Y: 0%

**Part 2**: Both the x and y components for graphical and simulation were similar to the calculated value, with the simulation being closer to the calculated value in both cases.   
Graphical  
X: 1.09%  
Y: 1.17%  
Simulation  
X: 0.311%  
Y: 0.131%

**Part 3**: The graphical method resulted in a magnitude and angle that fell short of the calculated value while the simulation resulted in a comparable magnitude and an angle that is only different because of rounding.  
Graphical  
Magnitude: 9.45%  
Angle: 7.35%  
Simulation  
Magnitude: 0.394%  
Angle: 0.0231%

**Part 4**: The graphical method resulted in a magnitude similar to the calculated value, but the simulation resulted in a magnitude much closer to the simulated value. The graphical method resulted in an angle (smaller if you count from 0˚ to -180˚ but larger if you count from 0˚ to 360˚) than calculated while the simulation method resulted in an angle that is only different from the calculated due to rounding.  
Graphical  
Magnitude: 1.64%  
Angle: 3.45%  
Simulation  
Magnitude: 0.425%  
Angle: 0.0101%

In every case, the simulation method had either an equal or lower percent error compared to the graphical method.

**Questions for Discussion**

1. If you had three equal magnitude forces, all three applied to the same point, and one of the forces is directed along the X-axis, what angles would the other two vectors need to be to result in a zero net force?

Assuming the first force was at 0˚, the other two would have to be at 120˚ and 240˚. This is because that is the only way to have three forces spaced equally apart so they could cancel each other.

1. In Parts 1 and 2 you are finding the components of a velocity vector equal in magnitude to 20 m/s. They have the same magnitude, but not the same values for the X- and Y-components. Explain why this is so.

This is because they are set at different angles. The equations to find the x and y components are as follows, “x=h\*cosφ” and “y= h\*sinφ” where h is the magnitude and φ is the angle. Although the magnitude remains the same between parts 1 and 2, the angle changes which would change the output obtained from the equation.

1. This experiment involved adding two and three vectors together. Describe how, graphically, you would represent subtracting a vector from another vector.

Draw a line with the same angle but a negative magnitude. For example, to subtract a vector of 10 at 20˚, draw a line at 20˚ with a magnitude of -10.

1. Is it possible to add a force vector to a velocity vector when representing increasing the velocity of an object by applying a force? If so, show a vector diagram representing this, along with the Resultant vector. If not, explain why not.

No, force vectors and velocity vectors are different and cannot be combined into a resultant vector.