Name: ______________________________ Section: __________ Date: ____________

Worksheet - Exp 3: Vector Addition

Objective: This lab is an exercise in manipulating vectors in both polar and component form.

1. Give your friend Steve directions to your house. (2 pts)

   "Walk ______ blocks east and then ______ blocks north."

2. This is *component notation*. You can add together several directions to arrive at the same location.
   For example: (2 pts)

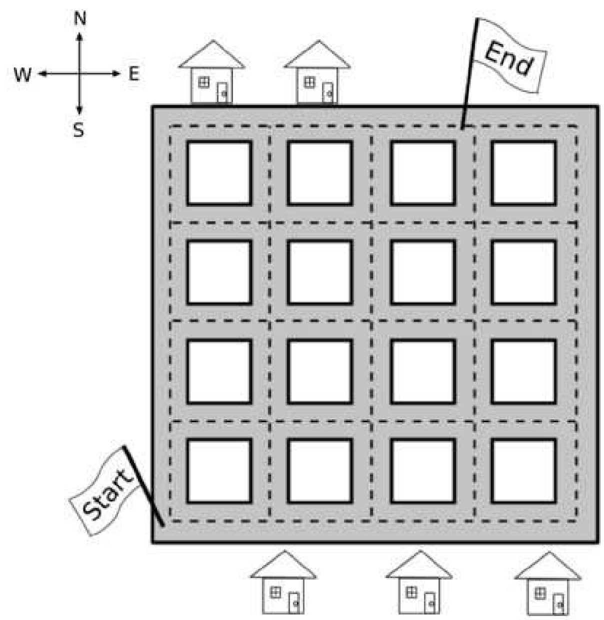
   "Walk one block east and two blocks north. Then

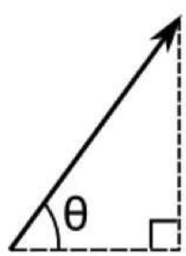
   walk ______ blocks east and ______ blocks north."

3. Steve may decide instead to fly to your house. In that case, tell him what direction to face and how far to fly. Label the triangle below. (6 pts)

   $\theta =$ __________ $r =$ __________

   This is *polar notation*. The direction, θ, is always measured counterclockwise from "east" as shown below.





4. The *equilibrant* is the one vector that returns Steve home (his origin), regardless of how he arrived at your house. Write the equilibrant in component form and polar form so that Steve can walk (or fly) home. (8 pts)

<u>Component</u> x-component: ______________ <u>Polar</u> magnitude: ______________

y-component: ______________ direction: ______________

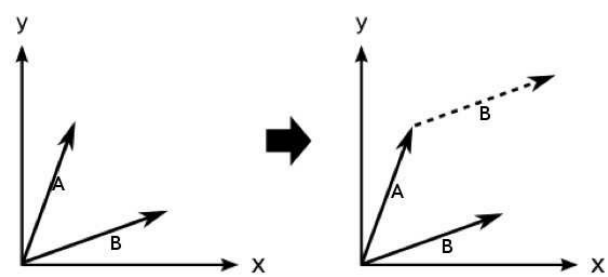
Procedure:

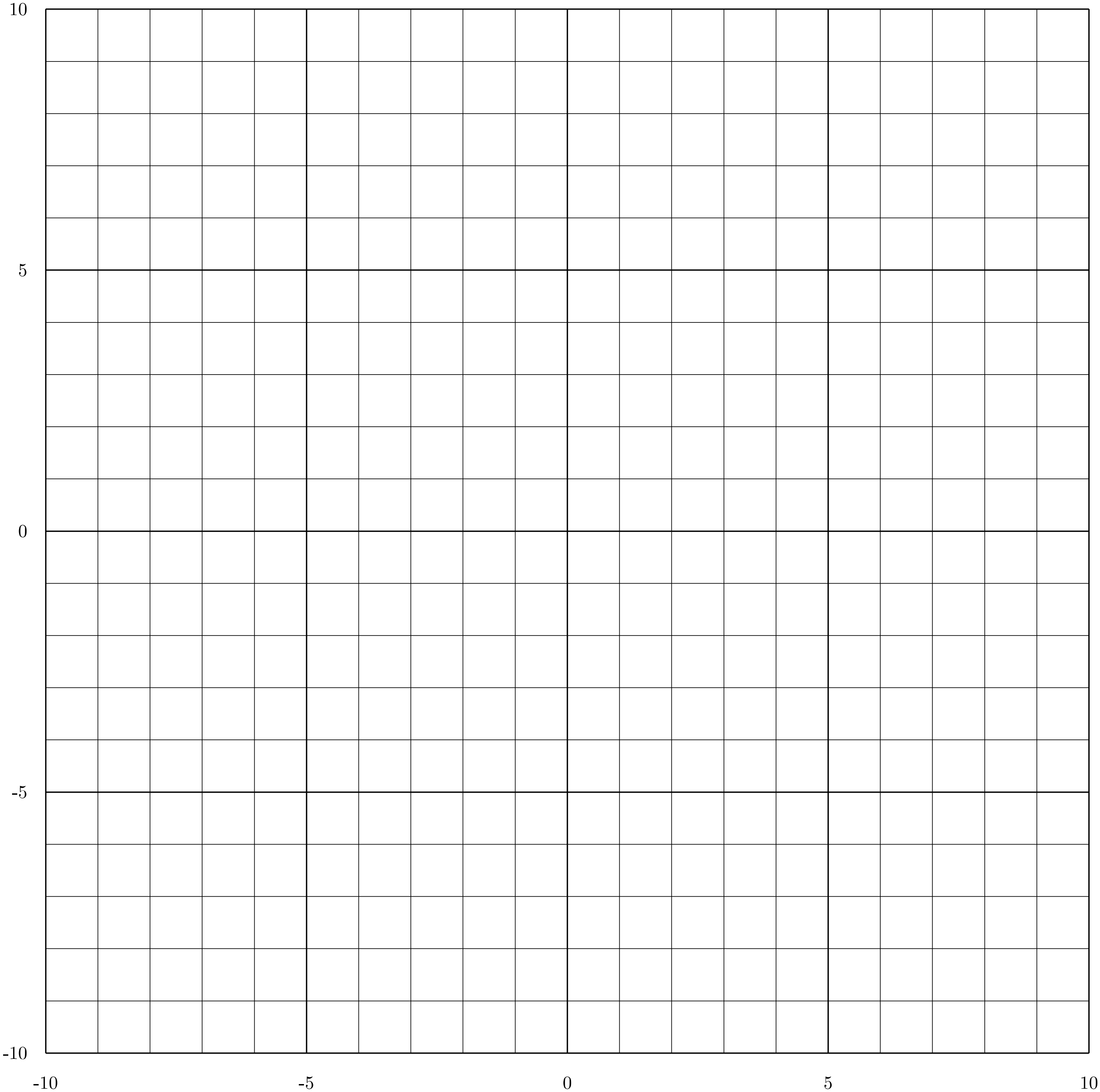
Part 1: Tail-to-Head Method

5. Your TA will provide you with a set of three force vectors, record them in the table to the right. Let 1.00 N = 2.00 cm on graph paper.
6. Using a ruler and a protractor, draw the three vectors on the coordinate system on the graph paper on the next page, starting each one from the origin. Use different colored pencils for each vector. (12 pts)
7. Add together vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$ graphically using the Tail-to-Head method. (3 pts)
8. Next, add the third vector, $\vec{\mathbf{C}}$, to the first two graphically. (3 pts)
9. Draw the resultant, $\vec{\mathbf{R}}$, from the origin to the tip of the last vector drawn, $\vec{\mathbf{C}}$. When the three forces $\vec{\mathbf{A}}$, $\vec{\mathbf{B}}$, and $\vec{\mathbf{C}}$ act together, they behave as though they were only one force, $\vec{\mathbf{R}}$. (3 pts)
10. Measure and record $\vec{\mathbf{R}}$ using the ruler and protractor. (3 pts)
11. Record the equilibrant that balances the three forces. (2 pts)

Vector	Magnitude (N)	Direction, θ
$\vec{\mathbf{A}}$		
$\vec{\mathbf{B}}$		
$\vec{\mathbf{C}}$		
Resultant		
Equilibrant		

Vector Addition,
Tail-to-Head method:




10
5
0
-5
-10
-10
-5
0
5
10

Part 2: Force Table

12. Use the level to level the force table.
13. Set three pulleys on the force table in the magnitude and direction of $\vec{\mathbf{A}}$, $\vec{\mathbf{B}}$, and $\vec{\mathbf{C}}$. Note: the mass hanger has its own mass. Let 1.00 N = 100 g on the force table. (It nearly does, $0.1kg \times 9.8\frac{m}{s^2} \approx 1\ N$)
14. Add a fourth vector to equalize the forces. This equilibrant force can have any magnitude and direction; you may use your equilibrant from *Part 1* as a guide.
15. Pull the pin from your force table to see if $\Sigma F = 0$.
16. If the forces are unbalanced, adjust the magnitude and direction of the equilibrant. When they are balanced, the fourth vector is your experimental equilibrant.
17. Calculate your accuracy against the theoretical equilibrant. Show your work below. Refer to the Appendix for Percent Error equation if necessary.

(28 pts):

Vector	x-component	y-component
$\vec{\mathbf{A}}$		
$\vec{\mathbf{B}}$		
$\vec{\mathbf{C}}$		
Theoretical Resultant		
Theoretical Equilibrant		
Experimental Equilibrant		
Percent Error		

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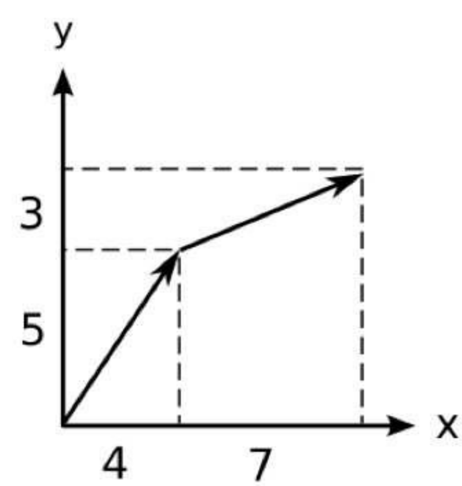
Extended Datasheet:
Vector Addition

Part 3: Vector Subtraction

(16 pts):

Vector	Magnitude (N)	Direction, θ	x-component	y-component
$\vec{\mathbf{D}}$				
$\vec{\mathbf{E}}$				
Resultant ($\vec{\mathbf{D}} - \vec{\mathbf{E}}$)				
Equilibrant				

18. Vectors $\vec{\mathbf{D}}$ and $\vec{\mathbf{E}}$ are given by your TA. Record them in the table provided.
19. Calculate $\vec{\mathbf{D}} - \vec{\mathbf{E}}$. (Note: Even though we are subtracting vectors, this is still a **Resultant** It may help you to draw a sketch.
20. Find the equilibrant.
21. Consider six vectors that are added tail-to-head, ending up where they started from. What is the magnitude of the resulting vectors? (3 pts)
22. Imagine you walk along the two vectors shown. What is the magnitude of your displacement? (3 pts)



23. How do you get back back to the origin? (3 pts) (give x- and y-components)
24. How would you get to the coordinates (15, 10) from the end of step 22? (3 pts)