ADDITION OF FORCE VECTORS:

UCONN Physics
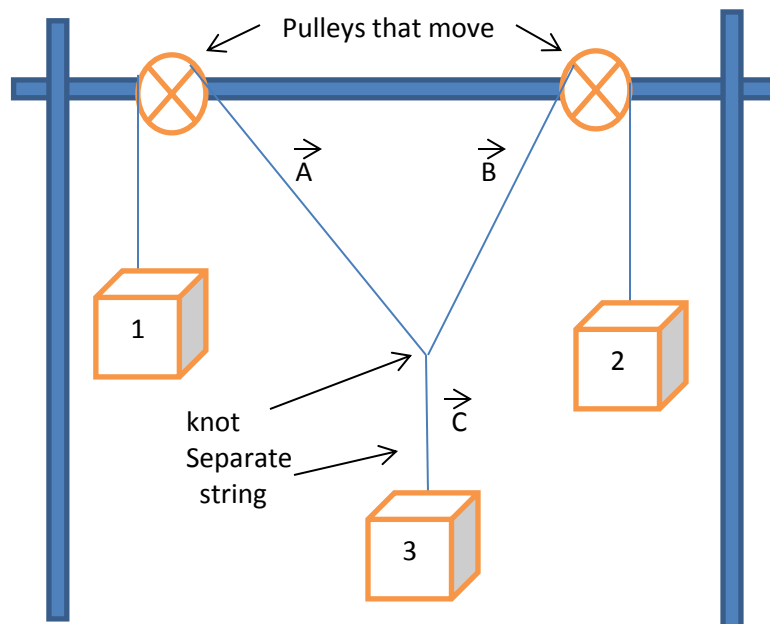
Name: _____

Date: _____ Period_____

Apparatus:	String	Protractor	Spring Scale
	Various hooked masses	Graph Paper	Metric ruler
	Lab Poles	pole clamps	Two single pulleys

The Investigation:

During this investigation you will try to demonstrate that the vector sum (resultant of any two of the three forces in equilibrium must be equal and opposite to the third force (equilibrant). Thus, vector A plus vector B in each case must be equal and opposite to the value of vector C. It can also be shown that vector B plus vector C is equal and opposite to vector A, and the vector C plus vector A is equal and opposite to vector B. Since each pair of forces produces a resultant that is equal and opposite to the remaining force, the entire system is in equilibrium. All forces are balanced. Furthermore, the vector sum of all three forces must accordingly equal zero.

Pre-Procedure:

1. What problem does this lab attempt to solve or prove?

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2. `Develop a hypothesis regarding the above stated problem.

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_____

3. Identify the Independent variable(s):

_____

_____

4. Identify the Dependent variable(s):

_____

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The Procedure:

1. Set up the apparatus as indicated in the above diagram. Hang a 500 gram mass as item #3 (or more). Hang approximately 200 grams from #1 and as many grams from #2 that will cause equilibrium. The top pulleys are adjustable, so use this to help your efforts if necessary.

Diagram #1:

1. Analyze the set up in procedure #1. Reconstruct the situation on graph paper (make a <u>sketch</u> at this point and label it "Diagram 1a"). Record the values of the masses in the table below and then again on your diagram.   To convert grams to Newton's, you must divide the mass in grams by 1000, then multiply this value by 9.8 m/s^2 .

Mass #1	Vector A		g		N
Mass #2	Vector B		g		N
Mass #3	Vector C		g		N

Now, make another Diagram but this time label it "Diagram 1b". Draw the three lines (Vectors A, B & C) to exacting scale. Hint, Draw Vector C first, followed by the others. Therefore you will need to create a scale to represent Newtons, such as (1 cm = 1 N, 10 mm = 1 N) or (2 cm = 1 N or 20 mm = 1 N), whatever suits your needs. You will also need to measure the angle between each of the vectors. In this diagram, clearly labeled Diagram #1, redraw what you see to exacting scale.

Scale:

1 N	_____mm

Vector A	N	mm
Vector B	N	mm
Vector C	N	mm

Diagram #2:

2. In this Diagram you must add Vector A to Vector B, graphically. Use your protractor and ruler to reconstruct these vectors graphically (to scale) on the graph paper.   The resultant of these two vectors (A + B) "should" add together to create a resultant that is equal and opposite to vector C. Therefore, since vector A plus vector B creates a resultant that is equal and opposite of vector C (A+ B = R or A + B = -C), vector C is known as the Equilibrant to Vector A plus Vector B.   Verify this <u>graphically</u>, in other words, use the scale you created and measure the exact length of this resultant and compare it to the value of vector C. What did you find?

(Graphical) Resultant of A + B =		N	mm

Diagram #3:

3. In this diagram, add vector A to vector B graphically, again. Draw the resultant of these two vectors added head to tail. Use the ruler and protractor to draw this diagram. Now in the space below the diagram, calculate the value of this resultant algebraically. You may use the component method or you may simply solve using the law of sines and/or law of cosines.

Ideally, you should get a value that is equal to the graphical value for the resultant of vector A plus Vector B (R or –C), as recorded previously.   Record the <u>algebraic</u> value below.

(Algebraic) Resultant of A + B =		N	mm

Now in the space below, calculate your %error. Use the formula below and show your work.

$\dfrac{O - A}{A}$ x 100%   O = Observed value of resultant

A = Accepted value of resultant i.e. what it should be.

Calculate the %Error in both cases of this lab. #1 in graphical situation #2 in Algebraic situation

Graphical Error   Algebraic Error

It is okay to have a negative error. Do not take the absolute value of the error!!! If the error is negative, you are that percentage below what you should have gotten, and a positive error indicates the error above what you should have gotten.

Diagram #4:

For this diagram, add vectors A, B, and C together, graphically. Theoretically these three vectors should add together to form <u>NO resultant</u>, as you found in #4 on worksheet I.   This explains why the system is in equilibrium. Equilibrium is where a resultant is balanced by an Equilibrant.!!! If you have an error in procedure #3, the three vectors will not form a closed triangle. What did you find?

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Postlab Questions: Answer each one completely!!

1. Did you find that the resultant of vector A plus vector B was equal and opposite of vector C? Account for any slight discrepancy you may have had in this resultant and vector C.

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2. Suppose you had added vector B to vector C. What resultant would you expect? Describe this resultant without using numerical values.

_____

_____

3. Suppose you had added vector C to vector A. What resultant would you expect? Describe this resultant without using numerical values.

_____

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4. Describe the term equilibrant as completely as possible.

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5.   How does the commutative law of addition apply to vectors?

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Attach all diagrams to this lab before turning in!

Score

_____ 10 % error

_____ 30 diagrams

_____ 10 postlab

_____ 50 Total

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