NOTE: please do NOT read this document before completing the lab "Commuting by Plane." Reading this document in advance will only HURT your lab experience & your learning and will NOT help you at all.

Commuting by Plane: Post Lab

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1. *Epistemological Table*

Please make sure that you have CAREFULLY read ALL of the directions explaining how to do Epistemological Tables provided in the post-labs for Lab 1 & Lab 2. If you are using Measured, Defined, Derived, or Calculated, you need to say “Measured with [*measuring device*],” “Defined: definition of [*term*],” “Calculated from [*equation*],” “Derived from [*definitions, postulates, etc.*].” Also, make sure you are clear on what “DERIVED” means.

Claim	**Type of Knowledge**
Total distance is the length of the path taken by any object on a particular trip.	
Total displacement is a vector which indicates the magnitude and direction of the straight-line distance from the start point to the end point of an object's motion.	
The final displacement using the first ordering of directions was 4 yards south, 1 yard east.	
Two equal and opposite vectors will cancel out to nothing. Two opposite but ***un***equal vectors will partly cancel out.	
Any diagonal vector can be broken up into horizontal and vertical components.	
The result of placing two or more vectors tip-to-tail can be found by adding the components of the vectors.	
The two orderings of directions that the research team tried both produced the same displacement.	
ANY possible reordering of the directions would DEFINITELY produce the same displacement.	

2. *Research Design Chart*

Because this week's lab isn't really a lab, the research design chart will work a bit differently from normal. This time there will be *five* boxes, but they'll go like this:

Box #1: what you observed about the 2 (or more) orderings you tried.
Box #2: the general conclusion you came to about how reordering vectors affects final displacement
Box #3: a logical/mathematical argument for the conclusion from box 2.
Box #4: a mathematical technique developed & used in the argument you made in box 3.
Box #5: how the mathematical technique from box 4 was used to solve the problem challenge problem at the end of the lab instructions and why this problem would have been very difficult to solve without that technique.

This is the basic structure of the chart, but in addition to this we're going to tell you specifically what should go in box 4. In box 4, you should put these words:

Given a set of coordinate axes (e.g. North-South & East-West) any vector that lies diagonal to these axes can be broken up into two component vectors which lie parallel to the axes (using trigonometric functions).

3. *The Counter Factual*

Imagine a lab just like "Commuting by Plane": you're given a set of directions and your job is to find an order in which to apply them to maximize final displacement. But there is one difference: instead of being in terms of *cardinal directions* (north, south, east, and west), the directions are in terms of *relative directions* (left and right), and you're given a set starting direction (e.g. due North). FOR EXAMPLE, one direction might be "Turn $90°$ degrees to the right and go 3 yards." Another might be "turn $45°$ to the left and go $4\sqrt{2}$ yards."

NOTE: this does NOT mean left or right from the point of view of someone staring down at the paper from above. It means left or right from the point of view of someone walking (or flying) along that vector path.

In this new scenario, ***would it be possible to produce different displacements by changing the order of the directions?*** Give a detailed explanation of your answer.

Your explanation must include at least one ***specific, diagrammed numerical example*** to demonstrate your claim. But note that a single example can't ***necessarily*** prove the point. Your job is to try enough examples and think hard enough about this scenario to be pretty confident of your position.

A really good explanation doesn't ***only*** have examples; it also has a ***general*** argument for why what happens in the examples makes sense & is logically necessary.

4. *The Wild Card*

In 3-5 complete sentences discuss how "Commuting by Plane" ***is*** and ***is not*** like a normal lab. What makes a lab a lab? ***Hint:*** what's the difference between math & science?

Commuting by Plane: Formal Report

Because commuting by plane is not actually a lab, a formal report on it will not resemble a formal report on other labs. You SHOULD include all of the sections of a standard formal lab report, but the narrative will be different.

Just as a normal Research Design Chart on a normal post-lab can help you create the narrative for your formal report, the weird mutant Research Design Chart in this post-lab can help you design the formal report for this non-lab.

To be specific, in a normal RDC, you start with a measurement (box 1); then you do some mathematical analysis on that measurement (box 2); and you draw a conclusion from that analysis (box 3) which bears on your research question (box 4). You do enough measurements and enough analysis, and eventually you are able to answer your research question. That's the LOGIC of a regular scientific lab, and that's the UNDERLYING LOGIC of a regular formal report.

In this case, the logic and the RDC go like this: you start with an observation; that observation inspires you to formulate a general rule/conclusion; you then try to figure out why that general rule/conclusion MAKES SENSE, using math & logic; in order to make that argument, you end up coming up with a mathematical technique (breaking vectors into components) which you then apply to a sample problem.

This whole narrative will play out in the Data Collection and Analysis sections of your report. The Abstract will still be a summary of the report. The intro will still be background & motivation for the inquiry. Research Question will be somewhat up to you, to pick a question that you think drives the inquiry. The diagram will show your two paths off the island, with displacement indicated on each map. Uncertainty will deal with any measurement uncertainty involved in your research. Conclusion will focus on the mathematical conclusions: (a) the general rule you discover, (b) the mathematical technique you discover, and (c) the answer to the sample problem where you use that technique. Appendices will hold any extra diagrams & tables, as needed, just as they always do.

In addition, make sure that you present at least TWO trials to maximize displacement from the island. For each trial, provide the TOTAL DISTANCE and the TOTAL DISPLACEMENT.

You must also fully and completely answer the supplemental question included in the lab. Your solution to this question must include:

1) at least one picture of 3 vectors (with arrow tips) placed tip-to-tail.
2) at least one vector represented as the hypotenuse of its own right triangle