Map Lab

Teacher's Guide

Topic:

Vectors and Projectiles

The following information is provided to the student:

Question:
How do the N-S, E-W legs of a trip compare to the overall displacement of that trip?

Purpose:
To identify the mathematical relationship between the N-S and E-W legs of a trip to the overall displacement for that trip.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion. The Data section should include the provided table with the required trips and one self-designed trip. The Conclusion/Discussion should identify the mathematical relationship between the legs of the trip and the overall displacement for that trip; the relationship should be general enough to be applied to any trip in order to determine the overall displacement from a statement of the legs. Two of the four trips (at least one of which is a three-legged trip) should be mathematically analyzed to provide the supporting evidence for your conclusion; work should be shown, labeled and discussed in an organized fashion.

Materials Required:

Street map of the community; metric ruler.

Description of Procedure:

Students receive a city street map and a metric ruler. They are assigned three to four destinations to reach, beginning at the school. They must travel along streets to reach the destinations. Using the street map and the indicated scale, students determine the north-south and east-west displacement which are required to reach the destinations. Finally, students determine the magnitude and direction for an *as the crow flies* displacement from the school to each destination. Results are analyzed to determine a pattern.

Alternative Materials and Procedure:

As an alternative to using a community street map, consider using a map of the state or country. Choose starting locations and destinations which can be reached by traveling along north-south and east-west highways.

Safety Concern:

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that the working environment is as safe as possible. Student *horseplay* and off-task behaviors should not be tolerated.

Suggestions, Precautions, Notes:

The Laboratory

1. Detailed maps of your community can often be obtained at City Hall. (Mention that you are a voter and that you train over 100 voters each year.) (If that doesn't work, pull out your wallet.) Laminating the maps may provide a low cost means of protecting them for years to come. Street maps for most communities can also be found on the internet.
2. As a starter lab on vectors, a focus on the magnitude of the resultant is an ambitious enough focus. Save a discussion of the direction and the trigonometric functions for a later lab.
3. If possible, select three to four popular locations which can be reached by traveling along one north-south street and one east-west street. Pick at least one location that requires at least three legs - e.g., traveling along two different north-south streets and one east-west street. If the school is not a convenient starting location (perhaps because it isn't near any businesses or it doesn't lie along a north-south or east-west street), then choose a different starting location.
4. Most students likely have had exposure to the Pythagorean theorem. Forcing them to apply it to this physics situation and to express the ideas in words is an excellent exercise.

Auxiliary Materials:

The following table is provided to the student for completion and inclusion in the Data section of their lab notebook.

Destination	East-West Legs (mag. and dir'n)	North-South Legs (mag. and dir'n)	Direct Route (mag. and dir'n)
School to _____	_____ _____	_____ _____	
School to _____	_____ _____	_____ _____	
School to _____	_____ _____	_____ _____	
School to _____	_____ _____ _____	_____ _____ _____	

Scoring Rubric:

VP1. Map Lab	Score
____ Included, labeled and organized all parts of the lab report. ____ Data section includes completed table with accurate measurements for all four trips; measurements are converted to miles (from cm). ____ Conclusion/Discussion should include an accurate and thorough statement of how the legs of the trips are mathematically related to the overall displacement. To provide evidence for the statement, a mathematical analysis of two of the trips is performed; one of the analyzed trips is a three-legged trip; work is organized, labeled and discussed.	____/____

Connections to The Physics Classroom Tutorial:

The following readings are a suitable accompaniment to this lab:

http://www.physicsclassroom.com/Class/vectors/u3l1b.cfm

http://www.physicsclassroom.com/Class/vectors/u3l1c.cfm

Connections to Minds on Physics Internet Modules:

Sublevel 4 of the Vectors and Projectiles module is a suitable accompaniment to this lab:

http://www.physicsclassroom.com/mop/module.cfm