Terrain Navigation Using Vector Calculus

GROUP STRUCTURE:

You need to work as a group to accomplish this assignment. Your group is to be made up of two to four students from your section. Select a *Group Leader* as soon as your group is formed. This person will be responsible for overseeing the project (schedule, tasks, etc.), leading the group, resolving issues, and interfacing with your instructor. Members will assist the leader (and the group) by following the leader's direction, offering counsel on the leader's decisions, and completing assigned tasks on schedule. Beware, without strong coordination, the "divide and conquer" method generally produces a substandard final product.

GRADING:

Part of your grade on this project will be based upon properly recognizing and executing mathematical procedures. The rest of your grade will be based upon the quality of your written communication, including explaining your processes. Unless you are working with the Math Resource Center on a special project, your instructor will grade your project. In totaling your scores, your instructor will give weight to these areas: mathematical accuracy/adequacy; quality of writing; and formatting / presentation. Except for teams that have clearly had an uneven distribution of work, all members will receive the same grade for the project. Your instructor will decide what constitutes an uneven distribution of work on a case-by-case basis with input from all team members.

INSTRUCTIONS:

Students should select project partners to form groups of two or three. Do not use the "divide and conquer" approach to solving the problem and preparing the analysis, figures, and report. Each member of the project group should be a full participant and make significant intellectual contributions to each facet of solving the problem and preparing the report.

Your 3-person teams will be crossing high, mountainous terrain as quickly as possibly. The terrain contains 2 prominent peaks. See figure 1. The teams will start at point A (-3,-3) and each team will pick a path to get to point B (3, 3). The altitude of the terrain is very high and is given by the function :

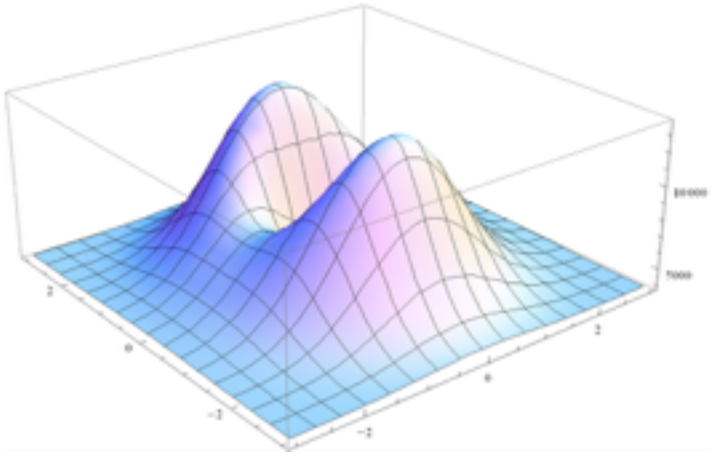

***Figure 1**: (x & y are in miles; A(x,y) is returned in feet above sea level)*

The speed of the teams as they move across the terrain in minutes/mile varies directly with altitude. Notice the units here are actually the inverse of speed so higher numbers actually mean slower travel. A team traveling across 10,000' terrain will travel at a predicted rate of 18 minutes/mile.

Teams will be trying to get from A to B as quickly as possible, but in order to make the race more interesting and to encourage teams to go between the peaks, a checkpoint has been established at point C(0,0). If a team fails to hit this checkpoint, 10 minutes will be added to their time as a penalty.

Your job as the adventure race planner is to first perform an analysis of the terrain. This should include a discussion of the highs, lows, and saddle points anywhere on the course. It should also include a discussion of the steepness of the terrain. Where is the steepest point on the course and what is the angle at that point with the horizon? In addition to identifying the points with the steepest terrain, any terrain with an angle greater than 60 degrees needs to be mapped out for the race director to allow for the proper placement of safety monitors. The teams will be given a contour map (provided by you) showing where this steep terrain is. They will be allowed to plan a route through this terrain but will be required to carry extra safety equipment which will add 5 minutes to their total time.

Once you have analyzed the terrain, you need to start anticipating the various paths the teams will possibly take and estimate the total time for each path. The race director believes a straight-line path will certainly be chosen by many teams due to the belief that since it is the shortest, it is probably the fastest. He also believes that many of the teams will do a more thorough analysis, go through the middle to hit the checkpoint, but still try to take advantage of the lower terrain without adding too much additional distance. Lastly, some teams will try to avoid going between the peaks altogether. These teams will get the 10 minute penalty, but the race director is unsure if this penalty is appropriate so he would like you to analyze it. He would like a penalty such that even teams that choose a longer path between the peaks come out slightly better than teams choosing a quicker path around the edge.

Properly planned communications are essential to execute a good adventure race and this race is no different. The race director knows that teams going between the peaks need access to a radio to call for help if someone is injured. In the event of an injury the teams are told to have one team member stay with the injured person while the other goes to a fixed shelter located at (1,0). A radio in this shelter can be used to call for assistance. Unfortunately, the radio can't be heard at the race command center. To fix this problem, the race director plans to have a signal repeater installed on the northern peak to ensure adequate communications. The Director would like your recommendation on the location of the repeater given the following constraints:

1) The repeater must be located on the northern peak

2) It must be placed at an elevation of 12,500' MSL

3) It should maximize the received signal strength from the shelter (units in milliwatts)

Remember, thorough planning is essential for a safe race so provide a lot of detail. Also, a picture is worth a thousand words so as you present your information to the race director, be sure to include appropriate figures and graphs. Good luck to you and your planning team.