Section 1: Summary of Analysis

**Part 1**

1. This section refers to the script ‘onea.m’.To plot the surface, the function surf was used. The mesh of x and y were used across the desired range (1-5.5 for x and -4-3 for y) with an increment 0.1. To plot the contours, the function contour was used. 30 elevations were displayed, with labels. A colorbar was also included to show the elevations. No calculations were required for this section. The plots can be seen below.
2. The area where the contour lines are the closest together show the steepest slope. This is because the rate of change as the function moves in the z-direction is faster than it moves in the x- or y-direction. This evidently shows a steep slope. From the contour plot, this is at approximately (3.5, 0). This section refers to the script ‘oneb.m’. To find the slope at a certain point, the gradient is calculated by taking the partial derivative with respect to x and y. The point is then substituted in, then the magnitude of the vector is found by taking the square root of the sum of the squares of the components. To find the highest slope, the slope is calculated at every point within the domain at a step size of 0.05. This is accomplished by iterating through each point using nested for loops. The highest slope is retained as a variable (maxslope) as well as the coordinates of this slope (maxx and maxy). The slope at the point is compared to the current maximum slope, and if it is larger, its value replaces maxslope. Once every point has been checked, the maximum value is displayed.
3. First, the critical points needed to be found. This is found in the script ‘criticalpoints.m’. The first partial derivatives of the function were displayed. These equations were then converted into forms that are compatible to use fsolve, meaning x was replaced with x(1) and y was replaced with x(2). These were declared as two functions (f1 and f2) in a function called “doublefunc”. Using fsolve requires initial guesses, which were obtained from the contour plot found in part a. There were 3 critical points, so the function was used for 3 values to determine the exact values. The function was then evaluated at these points.
4. The points needed to be classified. This is found in the script “onec.m”. The A, B and C values were found by taking the second partial derivative of the function. D was then declared as B^2-AC. Based on the conditions of D and A to classify the points, a series of if statements were created. The values of A,B,C,D and the classification was evaluated for each critical point.

Section 2: Summary of Results

Section 3: Appendixes

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| **Point #** | **(x,y)** | **f(x,y)** | **A** | **B** | **C** | **D** | **Type of point** |
| 1 | (2.9191, -0.7505) | -1.2236 | 4.4893 | 0.7479 | 4.8363 | -21.1523 | Relative minimum |
| 2 | (3.5963, -2.0459) | 0.1796 | -0.7658 | 0.2415 | -1.4008 | 1.0145 | Relative maximum |
| 3 | (3.5551, 0.6003) | 1.5883 | -5.8771 | -0.5401 | -4.2213 | -24.5171 | Relative maximum |

The location with the maximum slope is at (3.25,-0.1) with a slope of 3.1208.

The temperature at the highest elevation is 12.5386 degrees Celsius. The temperature at the lowest elevation is 26.6727 degrees Celsius. The temperature at the point (4,-0.3) is 13.6988 degrees Celsius.

In the north west direction, the directional derivative is 1.3469, therefore he is ascending. In the south west direction, the directional derivative is -0.7912, therefore he is descending.

Using Lagrange Multipliers, the highest temperature is the point (2.9147, -0.7548, -1.2235). The temperature at this point is 26.6744 degrees Celsius.