Part 3: Questions and Interpretation

<u>6.1 Coding</u>

<u>Question 1:</u>

We had you define the acceleration due to gravity as a field in a structure that you had to pass as an input argument to several functions. Instead, we could have had you type the value for the constant, 3.72 m/s2 directly in those functions. Do you believe there is an advantage to how we had you do it? Explain. Would you have done it differently? Explain why or why not.

> There is an advantage to defining the acceleration due to gravity as a field in a structure that we had to pass as an input argument to several functions. Had we just used the constant, 3.72 m/s^2, in place of our variable 'g,' modifying the data would take much more time. For example, if this rover were to be sent to another planet or moon with a different gravity constant, it would be as simple as changing one value which is called within several functions in the code. Otherwise, it would be necessary to go back into the code and change every single gravity constant that is used in hundreds of lines of code. To make it simpler had we been given the option, we would define 'g' as a global variable outside of all of the functions, meaning that a dictionary would not have to be called every time we use gravity.

<u>Question 2:</u>

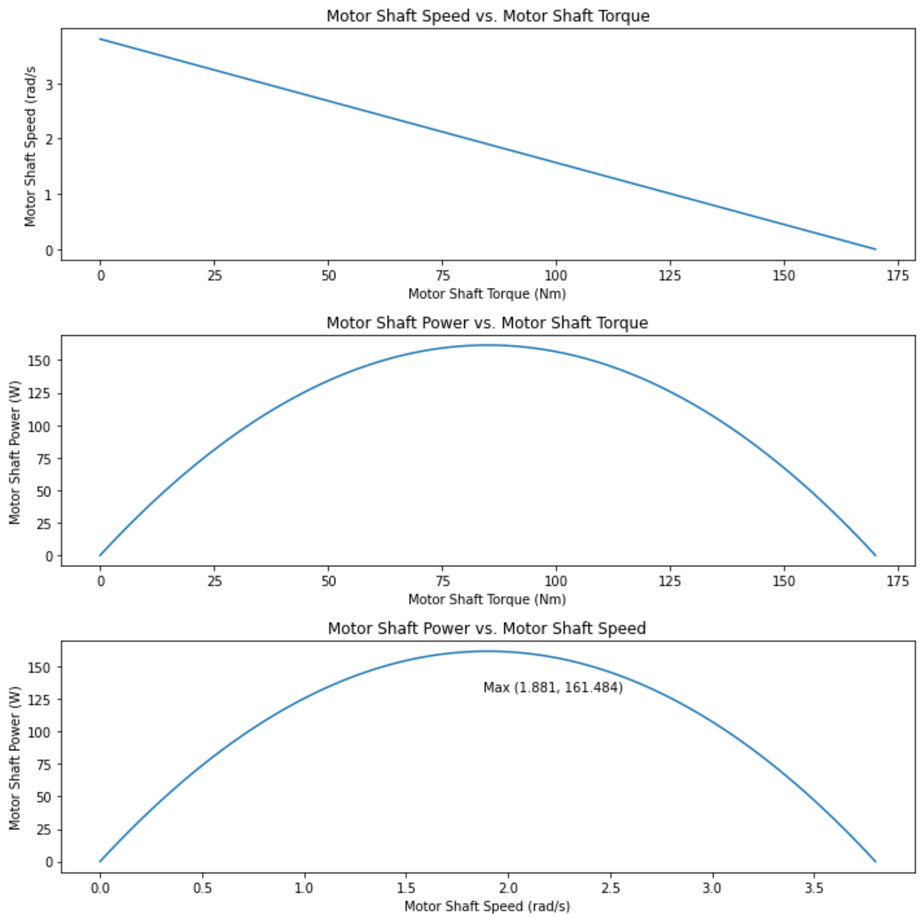
What happens if you try to call F_gravity using a terrain slope of 110 degrees? Is this desirable behavior? Explain why you think this.

> When we call F_gravity using a terrain slope of 110 degrees, we get an exception error. This is because we include a check within our F_gravity code that dictates the rover must stay within -75 and 75 degrees. If the rover was entering at a 90 degree angle, it would be coming in completely vertically, thus a terrain slope of 110 degrees would mean that the rover would be entering Mars upside down, which is not a desirable behavior. We want to ensure that there is a slight incline (-75 to 75 degrees) for the smoothest and best possible landing.

6.2 Motor and Speed Reducer Behavior

Question 3:

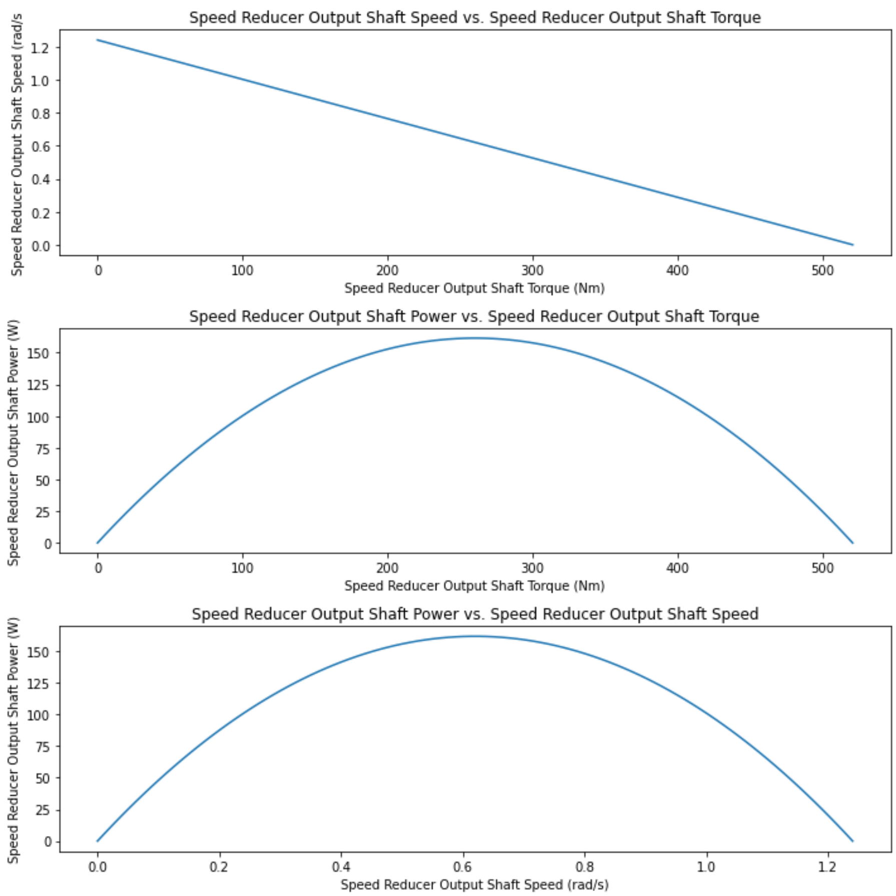
What is the maximum power output by a single rover motor? At what motor shaft speed does this occur? Provide graphs or other data to support your answer.



The maximum power is 161.484 W at a speed of 1.881 rad/s.

Question 4:

What impact does the speed reducer have on the power output of the drive system? Again, provide any graphs or supporting data.

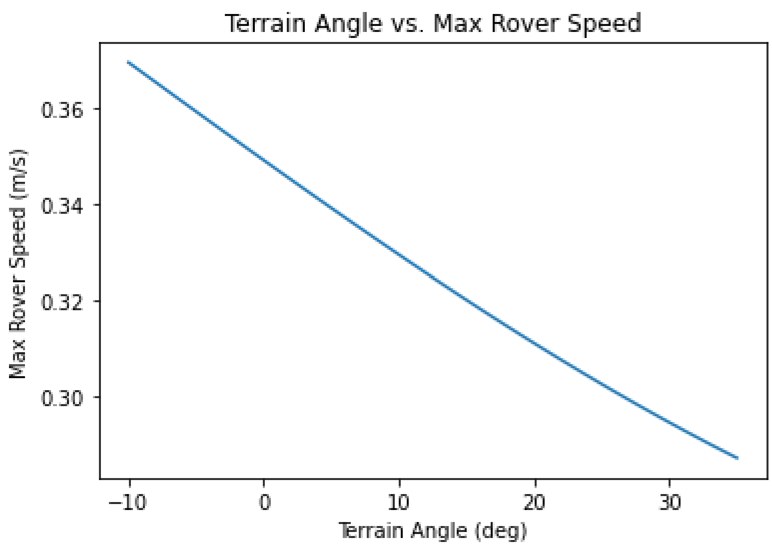


As shown in the second and third graphs which both model power in the y-axis, the bounds (from 0 to 150 W) do not change whether we use motor shaft data or speed reducer shaft data. Thus, the speed reducer does not have an impact on the power output of the drive system.

6.3 Rover Behavior

Question 5:

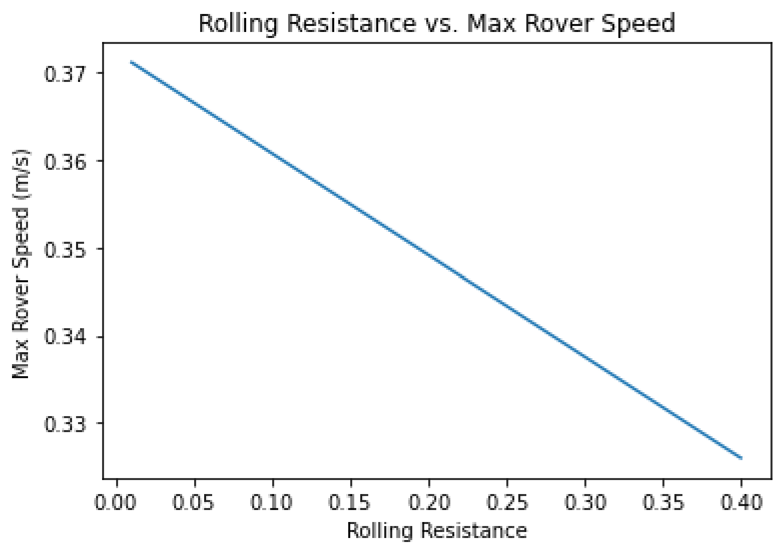
Examine the graph you generated using analysis_terrain_slope.py. (Provide the graph in your response for reference.) Explain the trend you observe. Does it make sense physically? Why or why not? Please be precise. For example, if the graph appears linear or non-linear, can you explain why it should be the way you observed? Refer back to the rover model and how slope impacts rover behavior.



As the rover inclines with increasing angle, the max speed decreases. This is because the larger the terrain angle, the rover has to work against a larger component of gravity. The gradual effect of gravity against the rover as the terrain increases causes the resultant graph to follow a non linear graph; it follows a similar path as the graph of the function e^{-x}

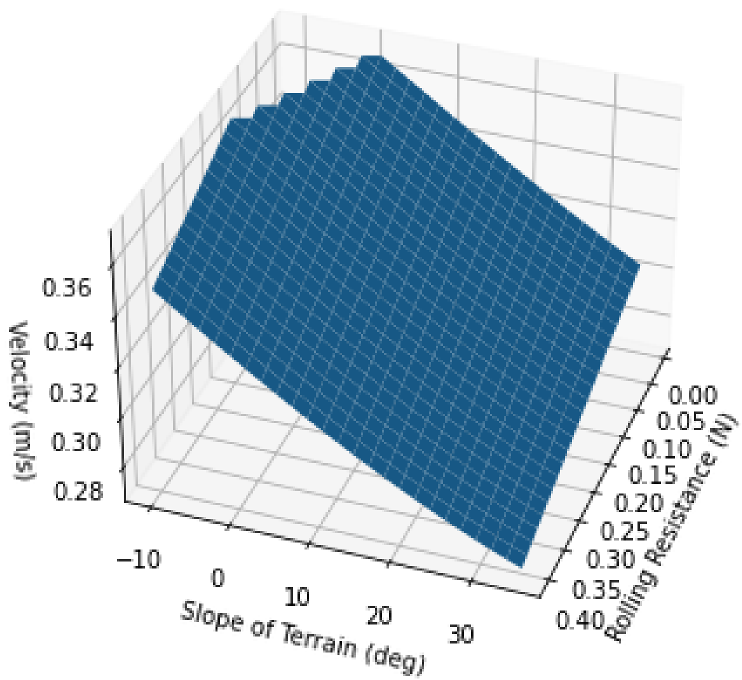
Question 6:

Examine the graph you generated using analysis_rolling_resistance.py. (Provide the graph in your response for reference.) Explain the trend you observe. Does it make sense physically? Why or why not? Please be precise. For example, if the graph appears linear or non-linear, can you explain why it should be the way you observed? Refer back to the rover model and how the coefficient of rolling resistance impacts rover behavior.



As the coefficient of rolling resistance increases, the max speed decreases. This graph follows a negative linear slope. The coefficient of rolling resistance represents the coefficient of friction, so as this value gets larger the velocity decreases due to the force of friction working harder against the rover.

Question 7:
Examine the surface plot you generated using analysis_combined_terrain.py. (Provide the graph in your response for reference.) What does this graph tell you about the physical conditions under which it is appropriate to operate the rover? Based on what you observe, which factor, terrain slope or coefficient of rolling resistance, is the dominant consideration in how fast the rover can travel? Please explain your reasoning.



This graph reflects the bounds and slopes of the last two graphs, but in a three-dimensional scope. This shows how the rover operates ideally when there is a smaller value for the coefficient of rolling resistance. Based on this graph, the slope of the terrain is the dominant consideration factor in the velocity of the rover. The slope of the velocity vs. slope graph is larger thanthat of the velocity vs. coefficient of rolling resistance.