Report for Apollo Mission

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I Introduction

It is very important to understand the impact of gravitational potential and the effects that the astronauts will experience when going to the moon. Gravitational potential is the energy that an object gains from the gravity of a planet. The distance away that an object is impacts how much energy the object has from this potential. This is important to look at because the rocket will experience different potential energy depending on its distance from the moon and the earth. This also relates to the gravitational force, which is the pull towards a planet caused by gravity that an object would feel at different distances from the Earth and the sun. On top of that, this report also looks at the functionality of the Saturn V Rocket, which will hopefully be used on our mission. It looks into the rocket velocity versus burn time.

II The gravitational potential of the Earth-Moon system

The first thing this report looked at is the gravitational potential on the rocket from the Earth and moon system. A code was created using the numpy program in Python. This allows for a graph to be plotted using a certain function. In this report, the distance from the earth was plotted and the color represents the amount of potential energy felt on the rocket at different distances. The colorbar is in logarithmic form in order to make it more readable. This graph shows that when the rocket is close to earth, it will feel a strong potential energy, which decreases as it goes farther from the earth. Additionally, the rocket will feel potential energy from the moon as it gets closer to it, but that has a smaller radius of where it will be felt. Additionally, a contour map was created to show the energy more clearly.

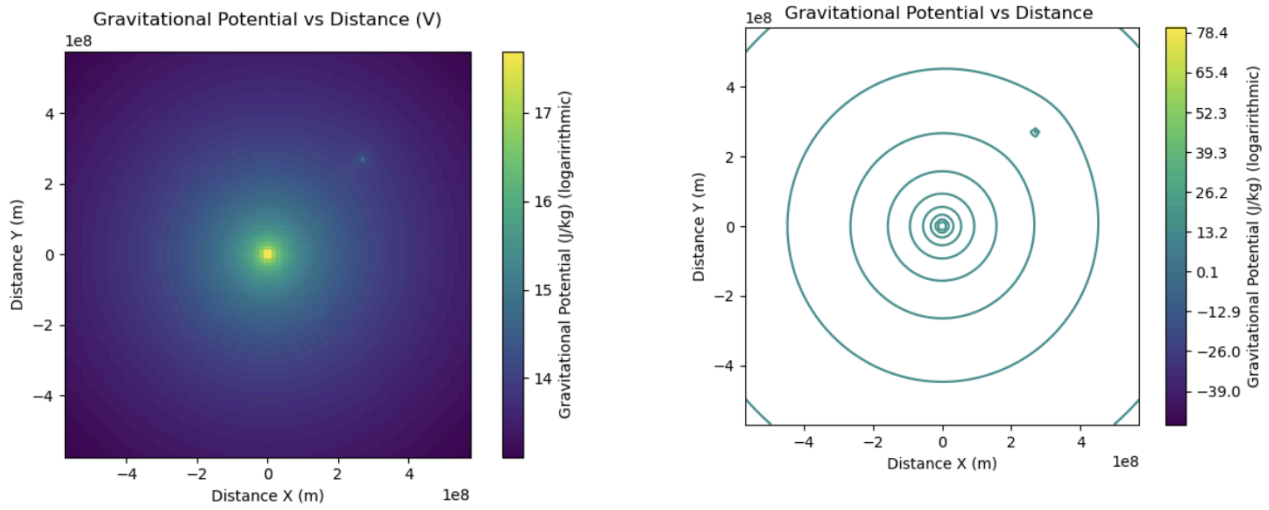

Figure 1: On the left is the graph produced in Python which shows the potential energy from the moon and the earth on the rocket. On the right is the contour map of the potential energy at different distances from the earth surface.

III The gravitational force of the Earth-Moon system

The report also explored the gravitational force that the Earth-moon system will exert on the rocket. This force would pull the rocket towards Earth's surface when the rocket is close to Earth, but as it gets farther away, this force becomes weaker. This graph is a stream graph which presents vectors in the direction of the force. The colorbar is on a logarithmic scale.

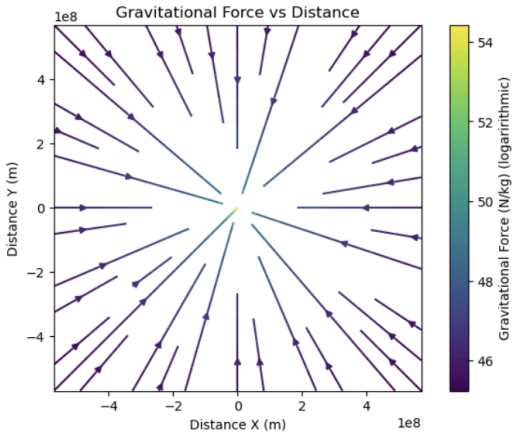

Figure 2: This figure shows the force pointing towards Earth, which is in the center of the graph, but the force grows weaker as the rocket gets farther away from Earth.

IV Projected performance of the Saturn V Stage 1

This report also calculated the burn time and altitude that the rocket could reach in that time frame. This was calculated using the quad function in Python, which does many small sums of the area under a graph to solve the integral. It was calculated that with Saturn V current wet mass, fuel exhaustion velocity, final mass, and fuel burn rate it has a current burn time of 129 seconds and can reach an altitude of 6.5e4 m.

V Discussion and Future Work

There were many approximations made throughout this report that should be explored more in the future. For the gravitational calculations, the earth was considered a point particle and the radius of the earth was neglected. Future studies should keep that in mind and should do the calculations without those approximations because they affect the distances used in the calculations. My calculations have a slightly faster burn time than Dean Kranz and a slightly shorter altitude reached. My calculation is likely an underestimate of both because it does not take into account the decrease in gravitational acceleration as the rocket gets farther from the surface and enters space. Additionally, air resistance was not taken into account, which could impact this report and could explain why the time and altitude calculated were shorter than NASA's time. A future model should not make these estimations to improve accuracy.

In conclusion, gravitational potential and force are strongest when the rocket is closest to the Earth, and the Moon. This report also looked at the burn time and altitude expected from Saturn V.