Results, Analysis & Discussion

After the model was computed, different orbital graphs are plotted to show the motion of the satellite when it crashes, orbits or escapes Mars. (The green X mark represents the satellite and the red circle represents Mars)

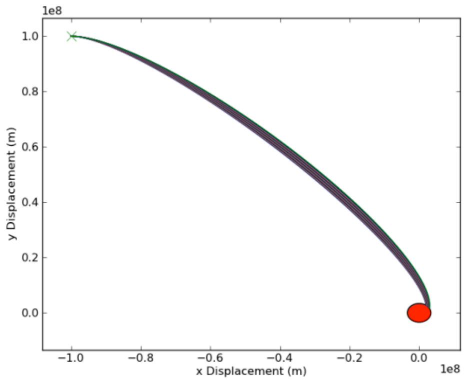

Figure 1: Satellite crashes into Mars

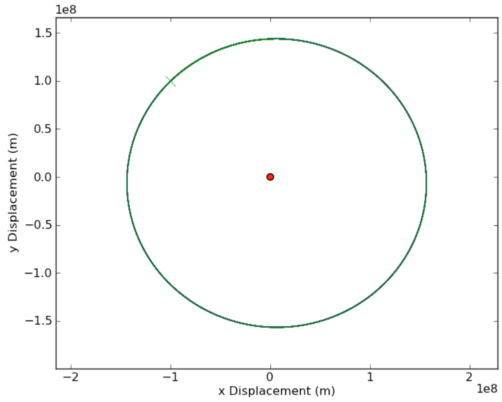

Figure 2: Satellite forms a circular orbit around Mars.

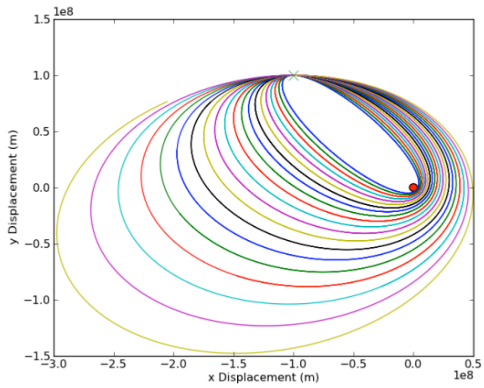

Figure 3: Satellite orbits around Mars elliptically.

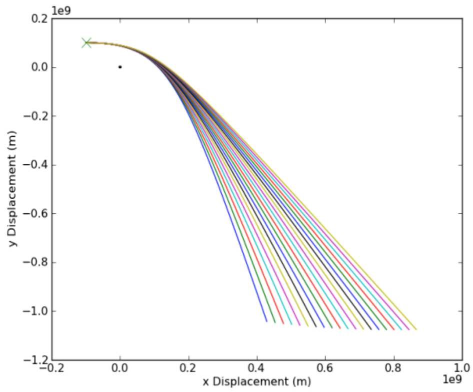

Figure 4: Satellite escapes Mars.

Different initial velocities give different graphs for the satellite motion. In this model, the y component of the velocity was set to zero and the x component of velocity is varied. It crashes when x velocity is $0ms^{-1}$ to $168ms^{-1}$ and escapes after x velocity = $650ms^{-1}$.

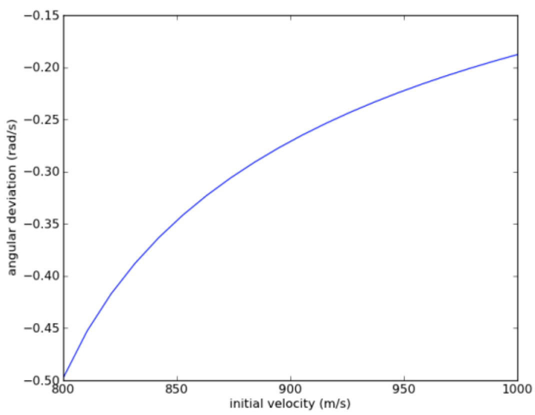

Figure 5: Graph of angular deviation against initial velocity

The angular deviation for the satellite motion when it is not captured is calculated and a graph of angular deviation against initial velocity is plotted. The graph shows that the higher the initial velocity, the smaller the angular deviation. This is because the higher the initial velocity, the higher the kinetic energy that the satellite has. Thus, if the kinetic energy is large enough, the gravitational force of Mars will not be able to attract the satellite. So, the satellite escapes more easily, with less angular deviation.

The energy graphs are plotted to observe the energy changes in a satellite's motion around Mars.

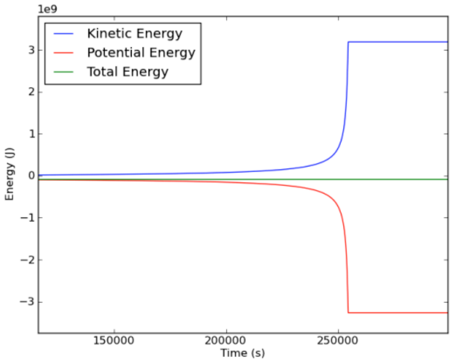

Figure 6: Graph of Kinetic Energy, Potential Energy and Total Energy against time when satellite crashes into Mars.

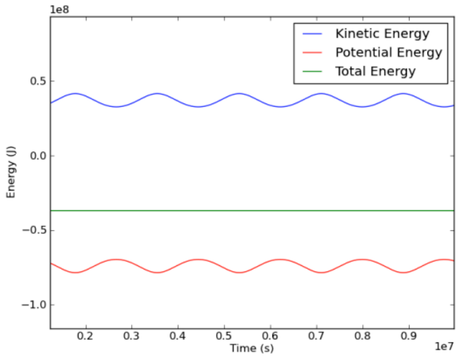

Figure 7: Graph of Kinetic Energy, Potential Energy and Total Energy against time when satellite orbits Mars circularly.

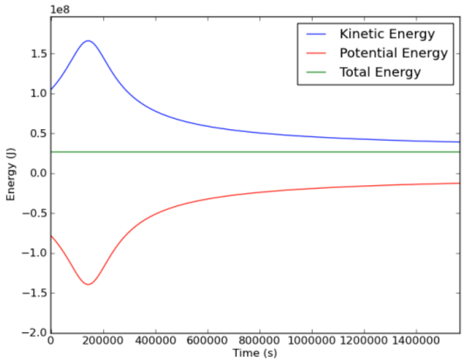

Figure 8: Graph of Kinetic Energy, Potential Energy and Total Energy against time when satellite orbits Mars elliptically.

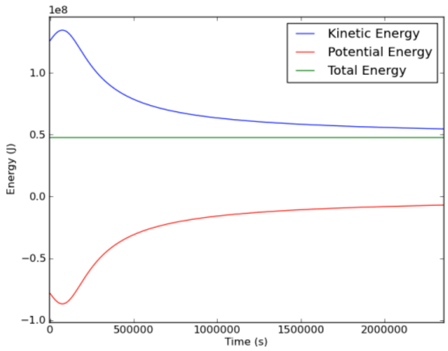

Figure 9: Graph of Kinetic Energy, Potential Energy and Total Energy against time when satellite escapes Mars.

The figures show the kinetic energy and potential energy that changes as the satellite approaches Mars. As the satellite gets closer to Mars, its kinetic energy increases due to the increase in its velocity and the potential energy decreases. In figure 7 and 8, the satellite is at its closest distance approach when the kinetic energy peaks and the potential energy reaches a trough. It then moves away from Mars. The total energy of all of the above graphs remains constant as total energy is conserved. However, if it is observed carefully, it is in fact not conserved. The graphs of total energy against time are plotted separately for each situation.

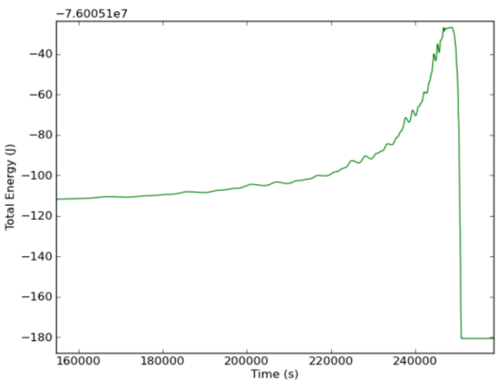

Figure 10: Graph of Total Energy against time for satellite crashing into Mars.

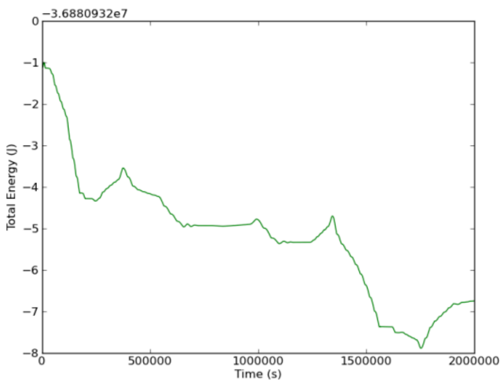

Figure 11: Graph of Total Energy against time for satellite orbiting Mars circularly.

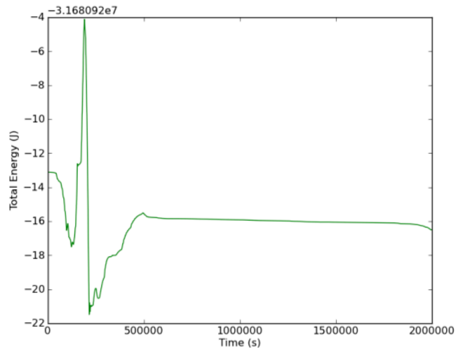

Figure 12: Graph of Total Energy against time for satellite orbiting elliptically.

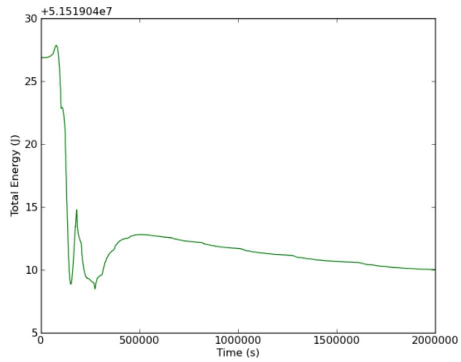

Figure 13: Graph of Total Energy against time for satellite escaping Mars.

The total energy is not conserved in each situation. Mars' motion is simulated and the motion of satellite is observed as well as the energy changes for when it escapes.

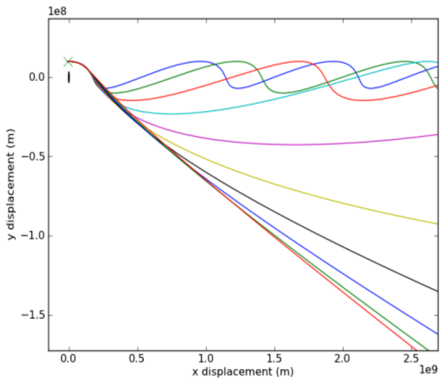

Figure 14: Satellite's motion when Mars is moving.

The motion of the satellite becomes sinusoidal when it orbits around moving Mars. When the satellite escapes, it either escapes Mars from behind or in front of Mars. The energy changes are different for each situation.

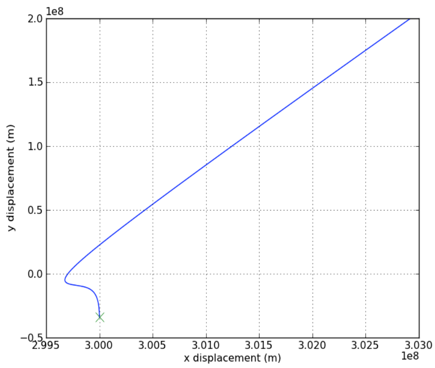

Figure 15: Motion of satellite when it escapes behind Mars.

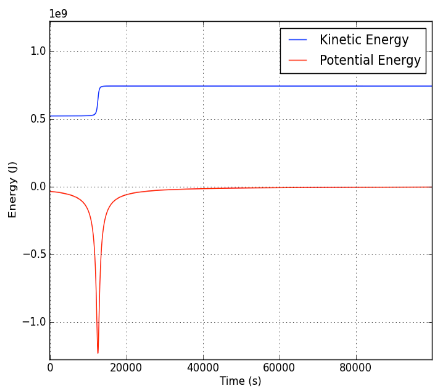

Figure 16: Graph of Kinetic Energy and Potential Energy against time for when satellite escapes from behind Mars.

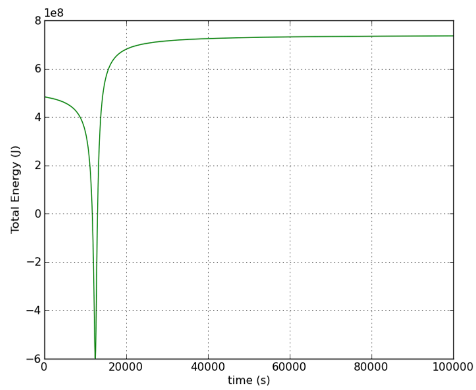

Figure 17: Graph of Total Energy against time for when satellite escapes Mars from behind.

When the satellite escapes Mars from behind, it gains kinetic energy from Mars as it goes behind of Mars. Hence, it escapes with an increase in its kinetic energy. The potential energy decreases when the kinetic energy increases. The total energy of the satellite increases due to the increase in kinetic energy.

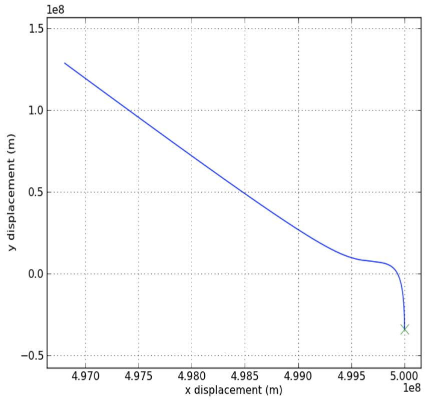

Figure 18: Motion of satellite when it escapes in front of Mars.

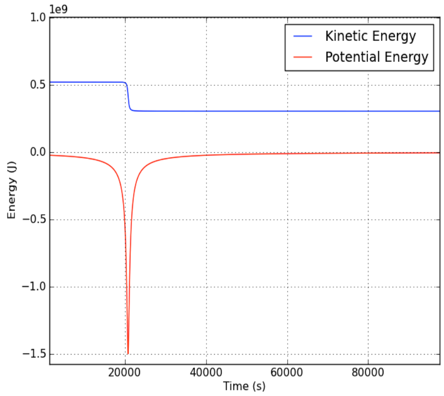

Figure 19: Graph of Kinetic Energy and Potential Energy against time for when satellite escapes in front of Mars.

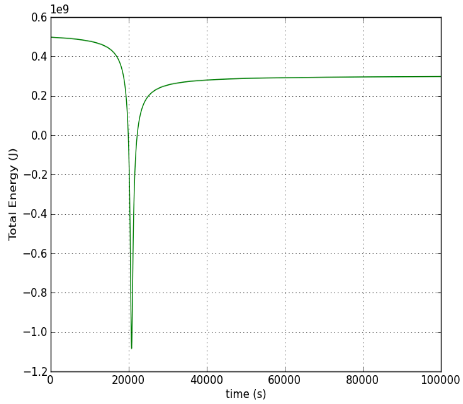

Figure 20: Graph of Total energy against time for when satellite escapes in front of Mars.

The kinetic energy of the satellite decreases when it escapes in front of Mars. As the satellite is attracted towards Mars, it slows down due to gravitational force, causing the kinetic energy to decrease. The potential energy also decreases as it is attracted towards Mars before escaping. The total energy of the satellite decreases due to the decrease in kinetic energy.