SCIENTIST 3: Code Workflow

First, a whole bunch of parameters and constants are set that are used for describing the motion of the rocket, including but not limited to: gravity and air density (on both Earth and on Mars), the drag coefficient and cross sectional area, the mass of the rocket and fuel, etc. The mass of the rocket was determined using the RNG generation code available on the D2L. The unique seed that was used for this program to generate mass values of the rocket was: *800813569666100101*. Next, the terminal velocity of the rocket is calculated for when the rocket is on Earth. The formula used to calculate the terminal velocity is as follows: $V_T = -\sqrt{\frac{2Mg}{pAC_D}}$

The code is then split into three loops that describe different phases of motion. Each of these loops work virtually the same, with the only difference between them including the direction forces are affecting the rocket, and therefore affecting the direction of acceleration for the rocket. The general algorithm of the loops includes calculating the magnitude of all forces present on the rocket at every iteration, then adding them all together and determining the current acceleration of the rocket. This acceleration is then applied to the velocity of the rocket, and then the velocity of the rocket is applied to the position value of the rocket. The first and last loop also have additional checkers to ensure that we never burn more fuel then we technically have, and to ensure that only motion before the rocket hits the ground is taken into account.

The first loop accounts for the motion of the rocket from launch all the way until the rocket runs out of fuel. In this loop, the thrust force is in the +y direction, while the drag force and gravitational force are in the -y direction. The loop ends when the total mass is equal to the mass of just the rocket (i.e. all fuel has been consumed.) The second loop accounts for the motion of the rocket that has run out of fuel, but is still moving in the +y direction. In this case, there is no force in the +y direction, so the acceleration is negative and the velocity is therefore dropping rapidly. This loop ends when the velocity of the rocket finally reaches 0. Finally, the last loop is accounting for the motion while the rocket is falling towards the earth. In this phase of motion, the drag switches directions and begins to work in the +y direction, while gravity is still in the -y direction. The acceleration starts off very negative in this loop, however as the velocity of the rocket increases, the drag force becomes stronger and stronger until the acceleration becomes very small. This phenomenon is the terminal velocity. This third loop has a checker that determines what time the rocket hits 95% of the calculated terminal velocity from earlier.

After all these calculations are complete, there are multiple print statements that describe what the maximum velocity, height and final velocities were, and when the rocket hit 95% of terminal velocity. Then all of the values for velocity and height respectively are plotted as a function of time. Finally, the code for loop 1 and loop 2 are then reused with parameters of this motion on Mars to determine the maximum velocity and height this rocket would have on Mars.