Derek Woodard, 100827083

ELEC 4700A Assignment 1

Part 1:

a) The thermal velocity is 1.87e+5 m/s or 187 km/s

b) The mean free path is 37.4nm

c)

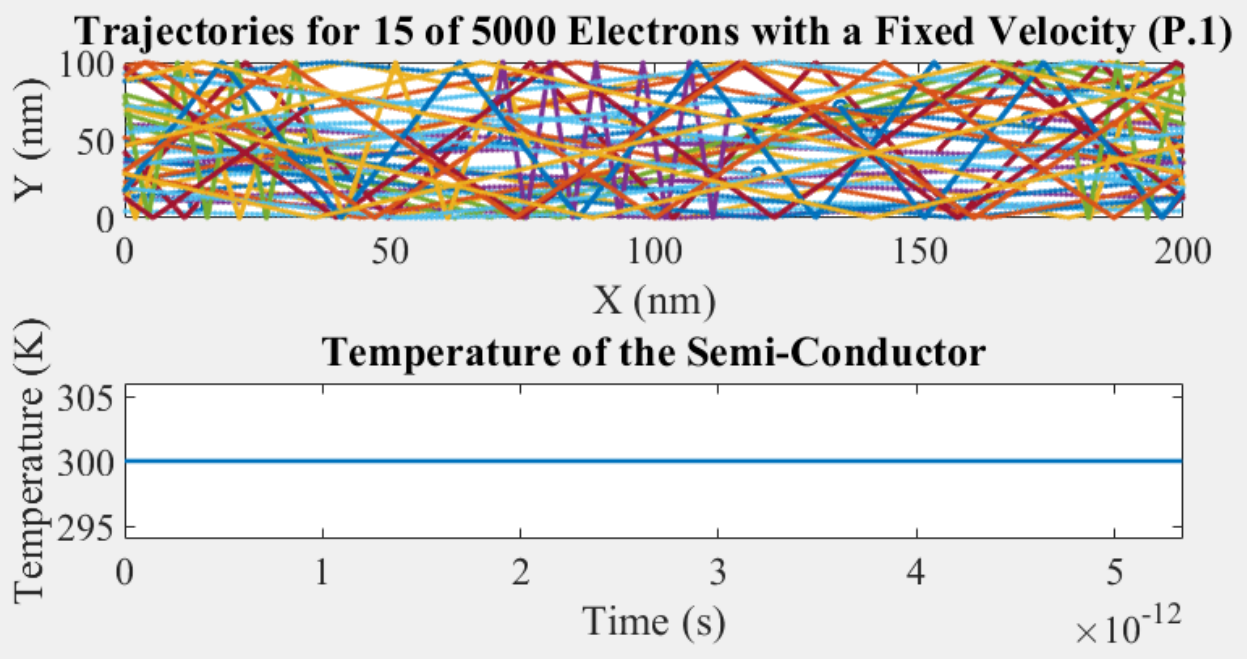

Figure 1: i) trajectory map of electrons, ii) temperature plot

Discussion:

As the electrons travel in the semi-conductor, they will reflect off the top/bottom with the same velocity, and they will be transported from left to right or vice versa if they leave the area. This consistent velocity is the reason for the lack of change in the temperature.

Part 2:

a,b,c)

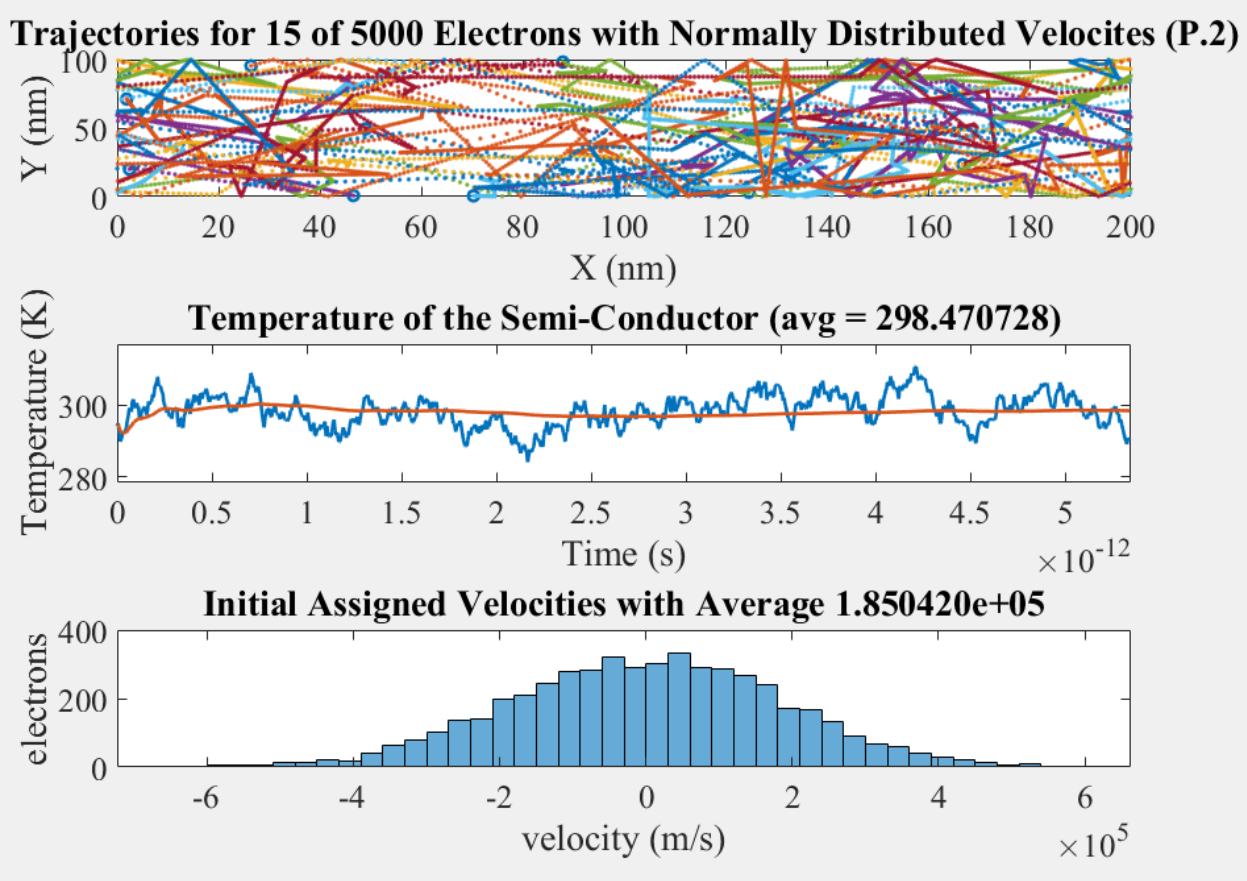

Figure 2: b) trajectory map, c) temperature plot, a) Histogram of velocity

c) The average temperature is plotted in orange. This value tends to close in at roughly 300K as time progresses.

d) The measured mean free path is 30.3nm

The measured time between collisions is 0.201ps

Discussion:

Using a normally distributed initial velocity around vth, the temperature now varies from the initial simulation. Combined with the scattering implementation, the temperature is constantly changing. Given that the new velocity selected is always from the distribution in the histogram, the average will always be drifting closer and closer to vth, giving an average temperature of roughly 300K, which is the same value as it was in part 1.

Part 3:

a)

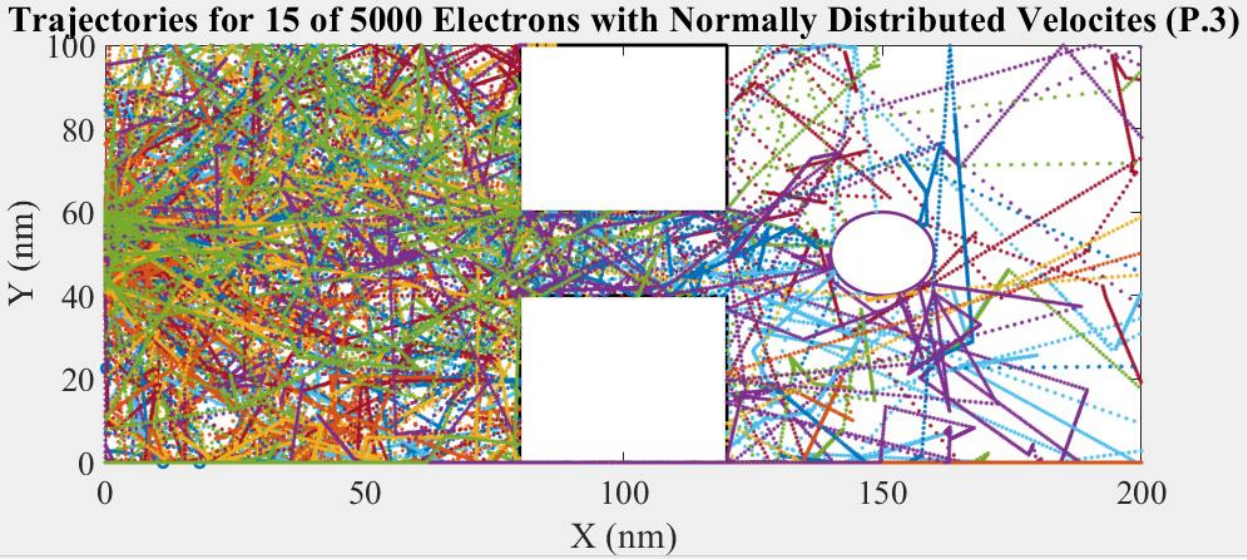

Figure 3: Trajectory Map

b)

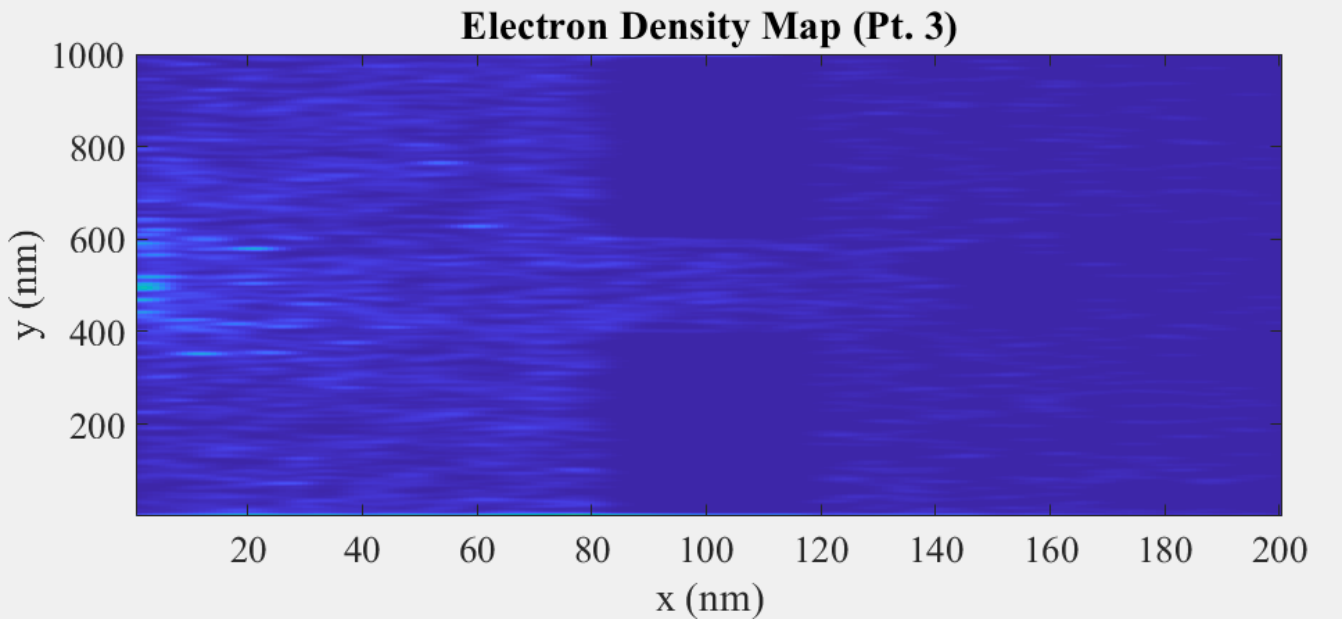

Figure 4: Electron Density Map

c)

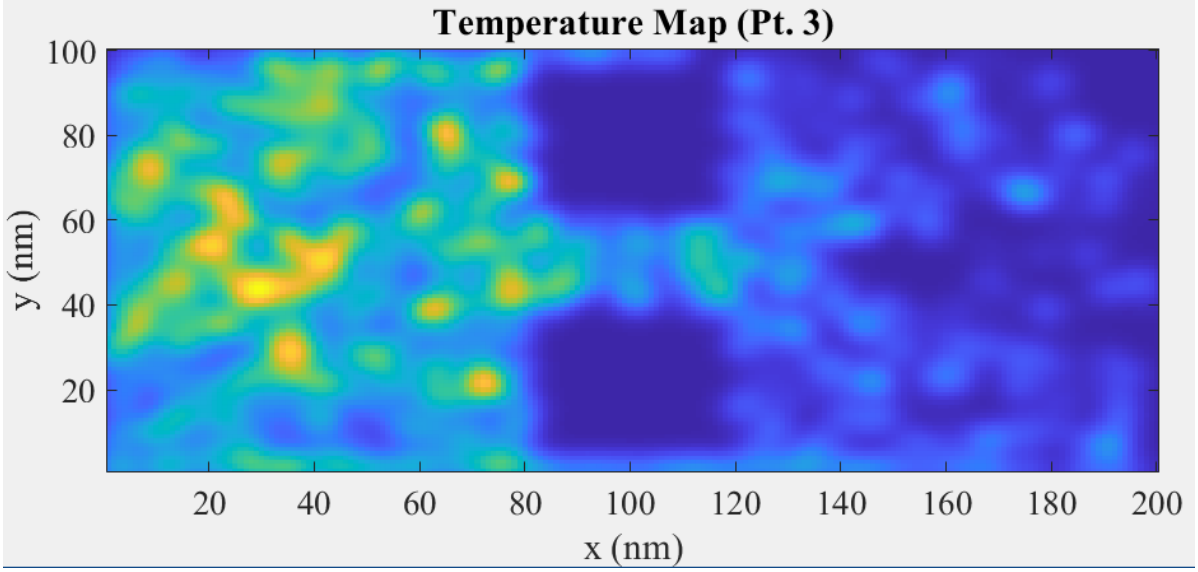

Figure 5: Temperature Map

3.2)

At the start of the simulation, there are no electrons. The electrons are injected into the system from the left side with a positive x-velocity. The electron initial Y-position is limited to the size of the bottleneck. Any electrons that reach the far right or far left of the system are essentially reset to the initial injection area with a new velocity to ensure that enough electrons are present in the system at the end.

A circular barrier has also been added at the end of the bottleneck. As electrons come into contact with the circle, the angle of incidence is found and they are reflected at the proper angle based on the angle of approach and the location of impact to the circle.

Discussion:

The same simulation as part 2 is run, but with new obstacles in the form of boxes. These boxes create a bottleneck.

The simulation also includes a circular barrier on the right of the bottleneck.

The electrons are injected into the system from the left side.

This bottleneck and barrier prevent many of the electrons from reaching the right side of the system, which is clear by all three of the figure (3,4,5) above. There are fewer trajectory lines on the right, fewer particles shown in the density map, and a lower temperature shown in the temperature map.