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%Author: Richard Finney 100967048

%%ELEC 4700 Monte-Carlo Modeling of Electron Transport
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Part 1

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%  The puepose of this code is to model the electrons in the silicon
 as particles
%  with the effective mass above using a simplistic Monte-Carlo model.


close all;

%Constants

q_0 = 1.60217653e-19;             % electron charge
m_0 = 9.10938215e-31;             % electron mass
kB = 1.3806504e-23;               % Boltzmann constant
deltat = 0.2e-12;                 % mean time between collisions
mn = 0.26*m_0;                    % effective mass of electrons



%variables

numofelec = 100;             %current numbers of electrons t be
 simulated
T = 300;                     %temperature in kelvin

dt = 1;

%the calculation of vth
vth = sqrt((kB*T)/mn);

%Spatial Boundaries

Length = 200;
Width = 100;

x = randi([0 Length], 1, numofelec)*1e-9;       %initializing x
y = randi([0 Width], 1, numofelec)*1e-9;        %initializing y

elecpos = [x;y];
previous=zeros(2,numofelec);

    %now we have position vectors for the x and y positions of each
    %electron. Need to create vectors for vy and vx. Remember that
 each
    %electron has a rand angle to start with, but same velocity vth.

angles = randi([0 360], 1, numofelec);
```

```
v_x = zeros(1, numofelec);
v_y = zeros(1, numofelec);

v_x = vth*cos(angles);
v_y = vth*sin(angles);

colorarray= rand(1,numofelec);
for time= 1:dt:1000
previous = [x',y'];
    dx = v_x*dt*1e-15;
    dy = v_y*dt*1e-15;

    x = x + dx;
    y = y + dy;

    %if y is greater than 200
    temp = y>=Width*1e-9;
    temp1 = y<Width*1e-9;

    temp = temp*(-1);

    temphigher = temp + temp1;

    v_y = temphigher.*v_y;

     %if y is less than 100
    temp2 = y>=0;
    temp3 = y<0;

    temp3 = temp3*(-1);
    templower = temp3 + temp2;
    v_y = templower.*v_y;



 %if x greater than 200
   temp5 = x<200*1e-9;

   x = x .* temp5;

   %if x is less than 0
   temp4 = x< -0.1;
   temp4 = temp4*200*1e-9;

   %temp4 = temp4*200*1e-9;
   x = x + temp4;

    %average thermal velocity
    v_avg = mean(sqrt((v_x.^2)+(v_y.^2)));
    T_avg = (mn*(v_avg^2))/kB;

    %mean free path

    mfp = (10^-12)*(v_avg);
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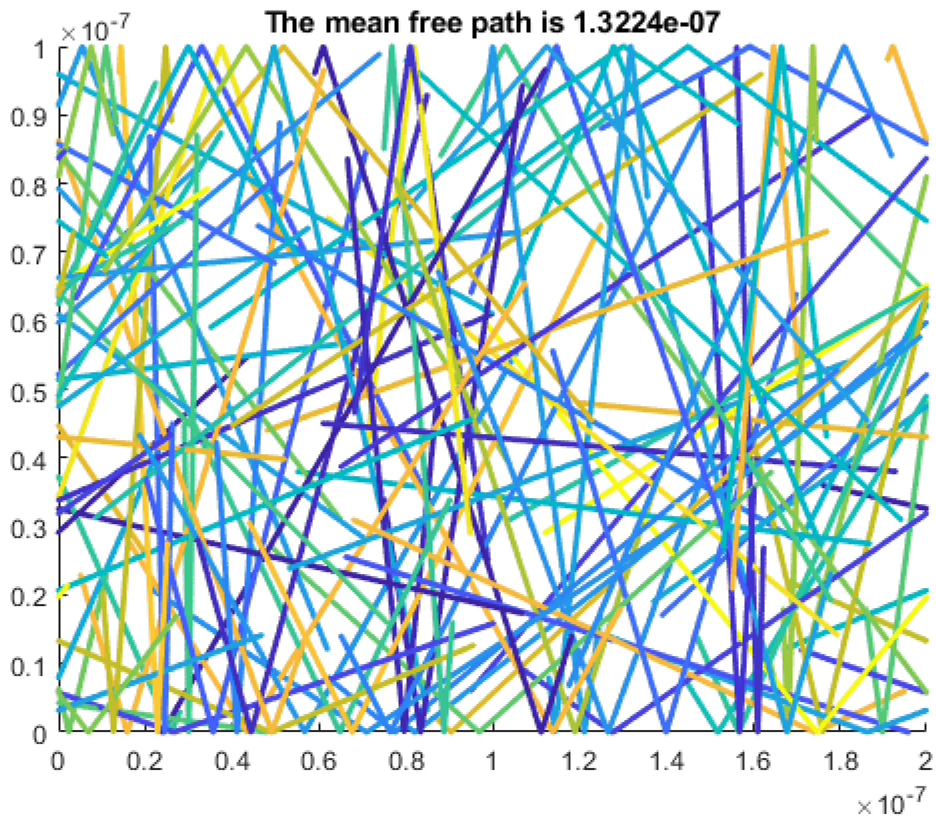
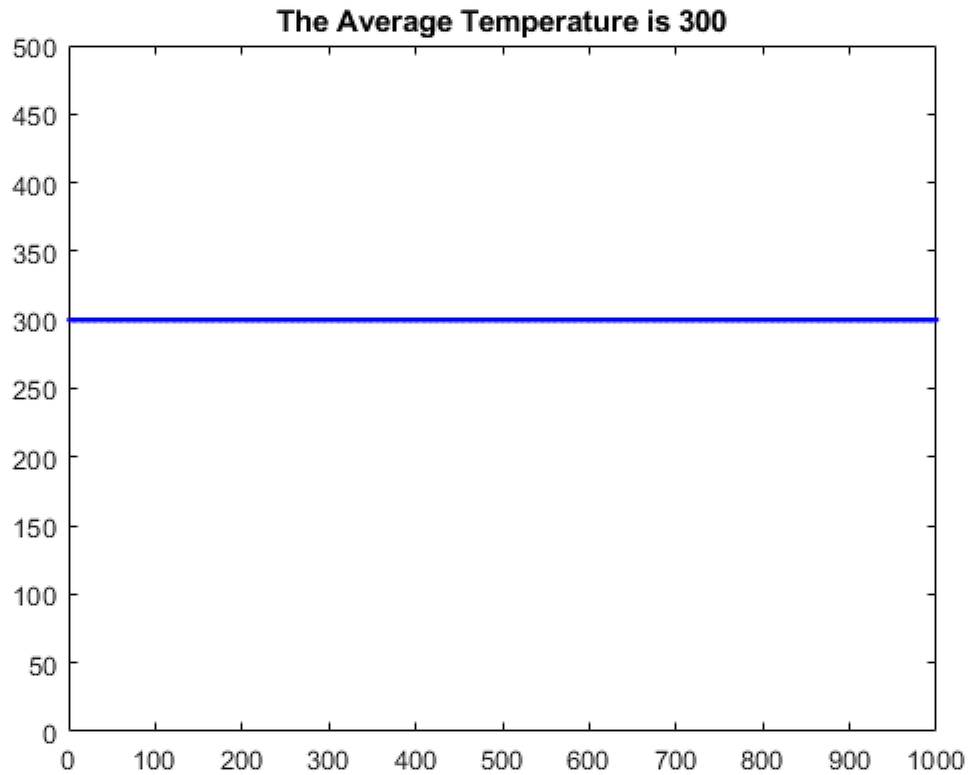
```
    %This is the 2D plot of particle trajectories
     figure(3)
     scatter(x,y,3,colorarray);
     axis([0 200*10^-9 0 100*10^-9])
     title(['The mean free path is ', num2str(mfp)]);
     hold on

     %This is the average temperature plot
     figure(4)
     plot(time,T_avg,'.b')
     title(['The Average Temperature is ', num2str(T_avg)]);
     axis([0 1000 0 500])
     hold on

end
%1) The thermal velocity is 1.334e+05
%2) The mean free path is displayed in the title of figure 3
```





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