Experiment-1

Title: *Write a program to calculate & plot diffusion distance of carbon in bcc Fe and fcc Fe as a function of time*

Similarly, plot diffusion distance vs time for diffusion of Aluminum in hcp Ti & bcc Ti.

Theory: Diffusion of carbon in occurs through interstices in the crystal structure. The approximate estimate of diffusion distance is given by

$$x = \sqrt{Dt}$$

where D is the diffusion coefficient in m^2/s, and *t* is time in seconds.

The diffusion coefficient is function of temperature as given below

$$D = D_0 exp^{-Q/RT}$$

where Q is the activation energy for diffusion J/mol.K

	C in ferrite	**C in austenite**
Q (J/mol.K)	80000	148000
D_o (m^2/s)	6×10^{-7}	2.3×10^{-5}

Calculate the diffusion distance at 600°C for bcc Fe and 900°C for fcc Fe.

Plot the two profiles in the same figure.
Use the command gtext in the program to indicate lines corresponding to Ferrite & Austenite.
Using the parameters given below plot the diffusion distance of Aluminum in α-Ti & β-Ti

	Al in α-Ti	Al in β-Ti
Q (J/mol.K)	331500	213100
D_o (m^2/s)	80×10^{-4}	0.114×10^{-4}

Program

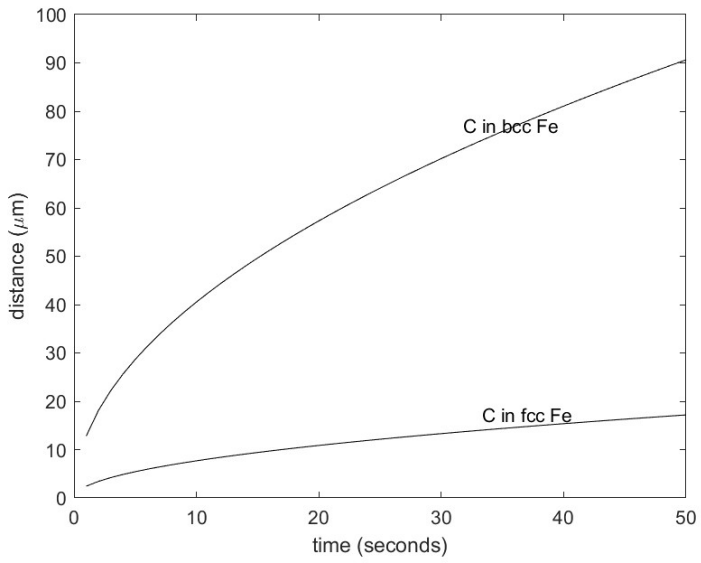
```
% diffusion in bcc Fe
Qf=80000; %80kJ
Qa=148000; %148kJ
Dof=6*10^-7;%m2/s
Doa=2.3*10^-5;%m2/s
```

```
R=8.314;%J/K.mol
T=900+273;%kelvin
D=Doa*exp(-Qa/(R*T));%m2/s
t=1:50;%seconds
x=sqrt(D.*t);%meters
x=x.*10^6;%micrometers
plot(t,x,'k')
xlabel('time (seconds)')
ylabel('distance (\mum)')
gtext('C in fcc Fe')
```

% after plotting the figure for bcc iron use the command 'hold on' at the prompt, change the temperature to 900°C, diffusivity & activation energy values to that for fcc iron. Now run the program to plot the figure for fcc iron on the same plot as bcc iron.
Use the gtext command and add your roll number on the figure

Result

The plot below shows the diffusion distance for bcc iron at 600°C and fcc iron at 900°C.



We use the data tip option to find the diffusion distance after 10 seconds in both bcc iron & fcc iron.

After 10 seconds at 600°C, diffusion distance in bcc Fe is 9.9 μm

After 10 seconds at 1000C diffusion distance in fcc Fe is 13.94 μm

*Compare diffusion distance in bcc and fcc Fe at **550ºC** & **950ºC**.*

Conclusion

Diffusion distance increases with temperature & time.
Carbon diffuses ….μm & ….μm in bcc iron at 600ºC & 550ºC.

Carbon diffuses ….μm & …μm in fcc iron at 900ºC & 950ºC.