

# MATE 313

Fall 2019

## Homework # 2

Due: **October 17<sup>th</sup>, 2019**

Group submission (up to 3 students per group) is allowed.

1

### Question 1

- Compute the radius  $r$  of an atom that will just fit into one of the tetrahedral interstitial sites in FCC crystal structure in terms of the atomic radius  $R$  of the host atom.
- Do the same computation for a octahedral site in BCC structure.

### Question 2:

The preexponential ( $D_0$ ) and activation energy ( $Q$ ) for the self-diffusion of aluminum are  $2.3 \times 10^{-4} \text{ m}^2/\text{s}$  and  $144 \text{ kJ/mole}$ , respectively. Determine the mean time of stay of an aluminum atom at a lattice site a) at  $300^\circ\text{C}$  and b) at  $600^\circ\text{C}$ .

2

### Question 3

Consider an atom diffusing by a random walk mechanism in a simple cubic lattice with a lattice parameter of  $0.2 \text{ nm}$ . It is known that the atom jumps  $10^{-5}$  times per second at  $300\text{K}$  and  $10^4$  times per second at  $600\text{K}$ .

- How many times the atom will jump per second at  $900\text{K}$ ?
- How far the atom will move away from its original position at  $900\text{K}$  in one minute?

### Question 4

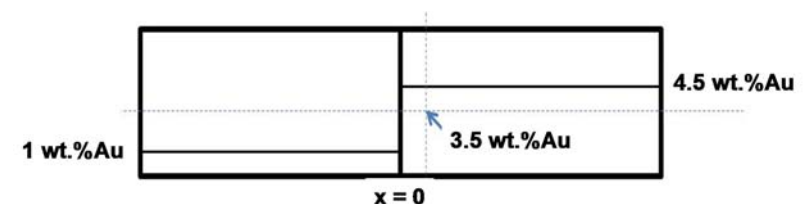
Carbon is allowed to diffuse through a  $12 \text{ mm}$  thick steel plate of austenitic microstructure. The concentrations of carbon at the two faces are  $0.80$  and  $0.45 \text{ kg/m}^3$ , which are maintained constant. Find the temperature at which the diffusion flux is  $6.3 \times 10^{-11} \text{ kg/m}^2\text{-s}$ .

### Question 5:

A diffusion couple composed of two platinum-gold alloys is formed; these alloys have compositions of  $99.0 \text{ wt\% Pt}-1.0 \text{ wt\% Au}$  and  $95.5 \text{ wt\% Pt}-4.5 \text{ wt\% Au}$ .

Determine the time this diffusion couple must be kept at  $800^\circ\text{C}$  in order for the composition to be  $3.5 \text{ wt\% Au}$  at the  $15 \mu\text{m}$  position into the  $4.5 \text{ wt\% Au}$  side of the diffusion couple.

Preexponential and activation energy values for Au diffusion in Pt are  $1.3 \times 10^{-5} \text{ m}^2/\text{s}$  and  $252,000 \text{ J/mol}$ , respectively.



4