

ME 301: HW Assignment 5 (50 points)

1. (a) Calculate the equilibrium concentration of vacancies per cubic meter in pure silver at 750°C. Assume that the energy of formation of a vacancy in pure silver is 1.10 eV. (b) What is the vacancy fraction at 700°C? Assume $C = 1$, Boltzmann's constant = 8.62×10^{-5} eV/K, atomic mass of silver = 107.87 and density = 10.5 Mg/m^3 . **[10 + 10 = 20]**
2. The surface of a steel gear made of 1022 steel (0.22 wt % C) is to be gas-carburized at 927°C (1700°F). Calculate the time necessary to increase the carbon content to 0.30 wt % at 0.030 in. below the surface of the gear. Assume the carbon content of the surface to be 1.20 wt %. Assume D at 927°C = $1.28 \times 10^{-11} \text{ m}^2/\text{s}$. Use Table 5.3 for your calculations. **[10]**
3. Calculate the diffusivity D in square meters per second for the diffusion of nickel in FCC iron at 1100°C. Use values of $D_0 = 7.7 \times 10^{-5} \text{ m}^2/\text{s}$; $Q = 280 \text{ kJ/mol}$; $R = 8.314 \text{ J/(mol.K)}$. **[10]**
4. The diffusivity of iron atoms in the BCC iron lattice is $4.5 \times 10^{-23} \text{ m}^2/\text{s}$ at 400°C and $5.9 \times 10^{-16} \text{ m}^2/\text{s}$ at 800°C. Calculate the activation energy in kJ/mol for this case in this temperature range. [$R = 8.314 \text{ J/(mol. K)}$.] **[10]**