DIFFUSION IN SOLIDS

1) The diffusivity of silver in solid silver metal is 1.0×10^{-17} m^2/s at 500C and 7.0×10^{-13} m^2/s at 1000C. Calculate the diffusivity (diffusion coefficient) of Silver in silver at 800°C.

2) A sheet of steel 2.5 mm thick has nitrogen atmospheres on both sides at 900C and is permitted to achieve a steady-state diffusion condition. The diffusion coefficient for nitrogen in steel at this temperature is 1.2×10^{-10} m^2/s , and diffusion flux is found to be 1.0×10^{-7} kg/m^2s. Also it is known that the concentration of nitrogen in steel at the high pressure surface is 2 kg/m^3. How far into the sheet from this high-pressure side will the concentration be 0.5 kg/m^3 ? Assume a linear concentration profile.

3) Consider the gas carburizing of a gear of 1020 steel. Calculate the time in minutes necessary at 927°C to increase the carbon content to 0.4 % at 0.50 mm below the surface.

   Assume that the carbon content at the surface is 0.9% and $D_{927°C} = 1.28 \times 10^{-11}$ m^2/s.

4) Nitrogen from a gaseous phase is to be diffused into pure iron at 700°C. If the surface concentration is maintained at 0.1 wt% N, what will be the concentration 1 mm from the surface after 10 h? The diffusion coefficient for nitrogen in iron at 700°C is 2.5 × 10-11 m^2/s.

5) The diffusion coefficients for nickel in iron are given at two temperature:

T (K)	D (m^2 /s)
1273	9.4×10^{-16}
1473	2.4×10^{-14}

   (a) Determine the values of D_0 and the activation energy Q_d
   (b) What is the magnitude of the D at 1100°C (1373K)?

6) The outer surface of a steel gear is to be hardened by increasing its carbon content. The carbon is to be supplied from an external carbon-rich atmosphere, which is maintained at an elevated temperature. A diffusion heat treatment at 850°C (1123 K) for 10 min increases the carbon concentration to 0.90 wt% at a position 1.0 mm below the surface. Estimate the diffusion time required at 650°C (923 K) to achieve this same concentration also at a 1.0-mm position. Assume that the surface carbon content is the same for both heat treatments, which is maintained constant. (For diffusion of C in a-iron , Q_d=80,000 J/mol and $D_0 = 6.2 \times 10^{-7}$ m^2/s)