Question Sheet 1

1. Show that a system which contains concentration gradients can be at equilibrium.

2. Show that in a binary $A, B$ solution,

$$\frac{\partial G}{\partial x} = \mu_B - \mu_A.$$

3. What factors contribute to the heat capacity of a polymer?

4. Explain why ordered crystals become disordered at a sufficiently high temperature.

5. What is an ideal solution? What is the probability of finding an $A$ atom next to a $B$ atom in an equiatomic ideal solution?

6. Calculate the equilibrium carbon concentration at any point given a fixed manganese concentration gradient in austenite. Austenite is an allotrope of iron. Assume that the activity ($a$) of carbon will tend to become uniform:

$$\ln\{a^0_C\} = \ln\{a^{Mn}_C\}$$
$$\ln\{\Gamma^0_C\} + \ln\{x^0_C\} = \ln\{\Gamma^{Mn}_C\} + \ln\{x^{Mn}_C\}$$

where $a^0_C$ is the activity of carbon at zero Mn, $a^{Mn}_C$ is the activity of carbon at a finite Mn concentration, $x^0_C$ and $x^{Mn}_C$ are the corresponding mole fractions of carbon, $\Gamma^0_C$ and $\Gamma^{Mn}_C$ are the corresponding activity coefficients. The activity coefficients can be expanded as follows (Kirkaldy and Baganis, Metall. Trans. 9A, 1978, 495):

$$\ln\{\Gamma_C\} = 8.1 \times x_C - 5 \times x_{Mn}$$

where $x_{Mn}$ is the concentration of manganese.