Massachusetts Institute of Technology
Kinetic Processes in Materials

3.21 Spring 2002

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Problem Set 1: Due Fri. Feb. 18, Before 5PM in 4-049

Exercise 1.1

Please solve Excercise 2.2 in *KPIM.*

Exercise 1.2

Please solve Excercise 3.1 in *KPIM.*

Exercise 1.3

Please solve Excercise 3.2 in *KPIM.*

Exercise 1.4

Please solve the following problem that has previously appeared on a 3.21 exam:

Consider a material that can conduct both heat and charge.

1-4-i Write out the linear equations that relate the heat flux and the charge flux to the operative driving forces $-(\nabla T)/T$ and $-\nabla\phi$, respectively.

1-4-ii Measurements of the heat flux are made and the data reported on the accompanying graph. Indicate, by illustrating directly on the graph the values of any of the Onsager coefficients for the linear force-flux relationships.

1-4-iii Consider the same materials system conducting heat and charge with a fixed electric field of strength $E_\circ$. Would you expect the *charge* flux at a fixed field $E_\circ$ to increase, or decrease, with increasing thermal gradient ∇T?

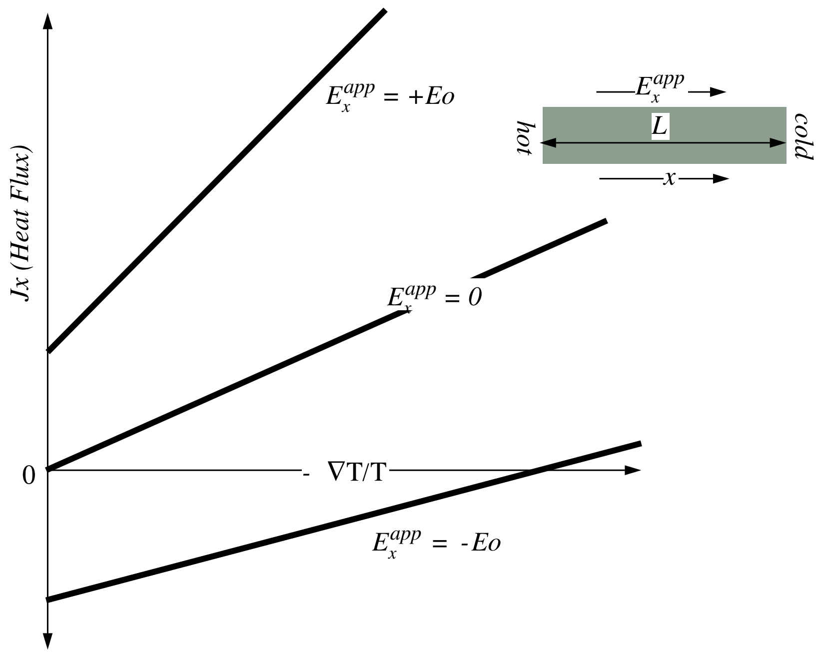

Figure 1-4-i: Data for Exercise 1.4.

Exercise 1.5

This is a question that can many different forms of solution and variable degress of completeness. Such questions may require that you and your homework group make and justify physical assumptions, or some type of simulation, or data extraction.

Consider diffusion in a binary solid solution of components A and B. The A–B alloy forms a regular solution with regular solution parameter $\Omega = 1.2 \times 10^4$J/mole, and the diffusion temperature is 900K.

Simulate diffusion by assuming the diffusion mechanism is direct exchange of near-neighbor pairs of atoms. Furthermore, assume that the jump frequencies for A–A, A–B, and B–B pairs have the ratio 2 : 3 : 5.

On the basis of your simulation results, what conclusions can you draw about the relative magnitudes of the Onsager coefficients L_{AA}, L_{AB}, L_{BA}, and L_{BB}?