Problem 7.1
Cu-Ni alloys have interactions that tend to favor Cu-Cu and Ni-Ni nearest neighbor bonds. At 700° C, they form disordered f.c.c. solid solutions over the entire range of alloy compositions. A single crystalline Cu-Ni thin-film sample with a sinusoidal composition modulation, averaging 50 atomic percent Ni, is prepared by a vapor deposition process onto a substrate that is maintained at room temperature. The sample is 100 nm thick and the modulation wavelength is 2 nm.

A Describe in words what will happen to the composition modulation if the modulated sample is annealed at 700° C (at which the atoms in the film are relatively mobile).

B Compare the rate of the diffusion process that you expect to observe in the thin-film sample with the rate of diffusion you would expect in a diffusion couple made by joining a piece of Cu to a piece of Ni, both of which are effectively semi-infinite in thickness. Which diffusivity will appear to be larger, and why?

Problem 7.2
Derive an expression for the temperature at which the rate of spinodal decomposition is a maximum (i.e., the “nose” of the C-curve). Use the mobility, free energy density, and gradient energy coefficients presented on pages 1-3 of the lecture handout dated 4-25-01 and evaluate the temperature for maximum decomposition rate.
**Problem 7.3**

This plot characterizes the number of particles as a function of their radius at time $t = t_o$. Suppose that, after $t_o$, the system undergoes diffusion-controlled coarsening. Sketch the curve at two later times:

A $t_1 = t_o + \hat{R}_1^2 / D_{eff}$

B $t_2 = t_o + \hat{R}_2^2 / D_{eff}$

where $D_{eff}$ is the effective diffusivity.
Please pay attention to variations in the total number of particles at each time.

**Problem 7.4**

Consider a system of isolated particles undergoing diffusion controlled coarsening. Suppose that, initially, all of the particles are coherent with the matrix.

A Qualitatively, what effect will the coherency have on coarsening? Consider both driving forces and transport mechanisms.

B What might cause a fraction of the particles to become incoherent? What effect might this have on coarsening behavior?