3.40J/22.71J
Physical Metallurgy Problem set 6. Solutions

Problem 1.
The answer to this problem depend on how good your solubility data are. The volume by Okamoto in Phase Diagrams For Dilute Binary Alloys has the best data I know of. You are by no means required to go to this source.
a, b. The Okamoto data are nicely linear with a pre-exponent of about 7. I would accept this value and extrapolate based on the data alone.

Other phase diagrams would give the solubility at the eutectic temperature and maybe a hundred degrees lower. It is hard to extrapolate on the basis of this data. I would force the plot through the theoretical value of 1 atom/atom at infinite temperature. I would also extrapolate on the basis of this plot, having confidence in the theory and the measured solubility at the eutectic temperature.

c. I would give the extrapolated value, with the warning that extrapolations are risky and just estimates. The extrapolated solubility is about 0 .0005 atom/atom. If you refused to commit yourself to even an estimate of a solubility, I suggest that you quickly start circulating your resume.

Problem 2.
Most of you presented good plots. In brief, for soft magnets you want a low remanence, low coercivity, high permittivity, high saturation magnetism, and low hysteresis . The high saturation magnetism allows for more a more compact transformer, and the low remanence and coercivity lead to a small hysteresis loop and little energy dissipation as the material is magnetized/demagnetized under an alternating current.

The hard magnetic material is just the opposite, except for also wanting a high saturation magnetization. The high coercivity means it is hard to magnetize and high remanence means it stays magnetized when the field is off. In short, you do not want these materials to magnetize and demagnetize easily. If they did, any little magnetic field could screw them up.

3.40J/22.71J Physical Metallurgy

Problem set 6.

<u>Problem 1</u>

Suppose that you are interested in a phenomenon which depends on the solubility of silicon in aluminum at half the absolute melting point, which corresponds to about 200 C. This scenario is realistic in that substitutional diffusion (ROT) is still significant at this temperature.

The following are ALL in atoms/atom, X.

a. Go to the literature for data on the solubility of Si in Al. Volume 3 of the ASM metals handbook is one source. Plot lnX vs. 1/T from the eutectic temperature to as low as you dare. Does it make sense to extrapolate your plot to 200 C? Why or why not?

b. The text states that the pre-exponent for substitutional solubility should be unity. That is, the solubility extrapolates to unity at infinite temperature. Plot your data with this pre-exponent.

c. Your boss hauls you on the carpet and demands your best estimate of the Si solubility in Al at 200 C. What number do you give and why?

<u>Problem 2</u>

a. Go into the magnetics literature and photocopy B-H curves for soft and for hard magnetic materials. Submit them with this homework.

b. Define all terms in both figures. Explain just what properties make each type a good or bad magnetic material.