ECE 6450 Homework #1

Some (perhaps not all) physical properties that might be needed in this homework:

Density of Si = 2.328 g/cm^3	Molecular weight of Si = 28.086 grams/mole
Density of Ge = 5.3267	Molecular weight of Ge = 72.61 grams/mole
Density of SiO_2 = 2.2 g/cm^3	Molecular weight of $Si0_2$ = 60.085 grams/mole
Atomic density of Si = 5e22 /cm^3	Atomic density of Ge = 4.42e22 /cm^3

Problem #1:

To increase the speed of their transistors, IBM and Intel are considering using $Si_{85\%}Ge_{15\%}$ (% atomic) instead of Si (not necessarily in the bulk form we discuss here). You are asked to grow a crystal of this material. A.) Assuming an equilibrium condition at the solid-liquid interface, approximately what temperature (at the interface) should you use and why (discuss the state of all phases at your chosen temperature)? B.) What range of compositions of the source charge (assume a finely mixed powder that has been thoroughly melted) results in the desired composition of the solid crystal? C.) If the total powder weight of the source charge is 100 kilograms, what range of weights of Si and Ge can be used? Note: this is a hypothetical problem only and does not accurately represent the complexities of the actual crystal growth process.

Problem #2:

A 3" diameter, 220 um thick Si wafer (volume~1 cm3) contains 18 ppm of Oxygen. The wafer is heated to 1100 degrees C for 6 hours. A.) By what amount does the oxygen concentration in the wafer exceed the solubility limit? B.) Assume, for simplicity, that all the excess oxygen above the solubility limit precipitates into SiO_2. What volume does the precipitate consume? C.) To get a feel for the magnitude of this volume, what is the size of a cube with this same volume? D.) What is the denuded zone depth formed? E.) What is the oxygen concentration in the denuded zone?

Problem #3:

(Hypothetical) Intel is going to use 300 mm diameter wafers for their new "Pentium X" computer chip. If each chip consumes 2 cm^2, and sells for $700 each, how much revenue does an Auburn Engineering graduate cost the company when he drops and shatters a fully processed wafer? Neglect all geometry effects such as a round wafer and square chip die, edge filling effects etc...