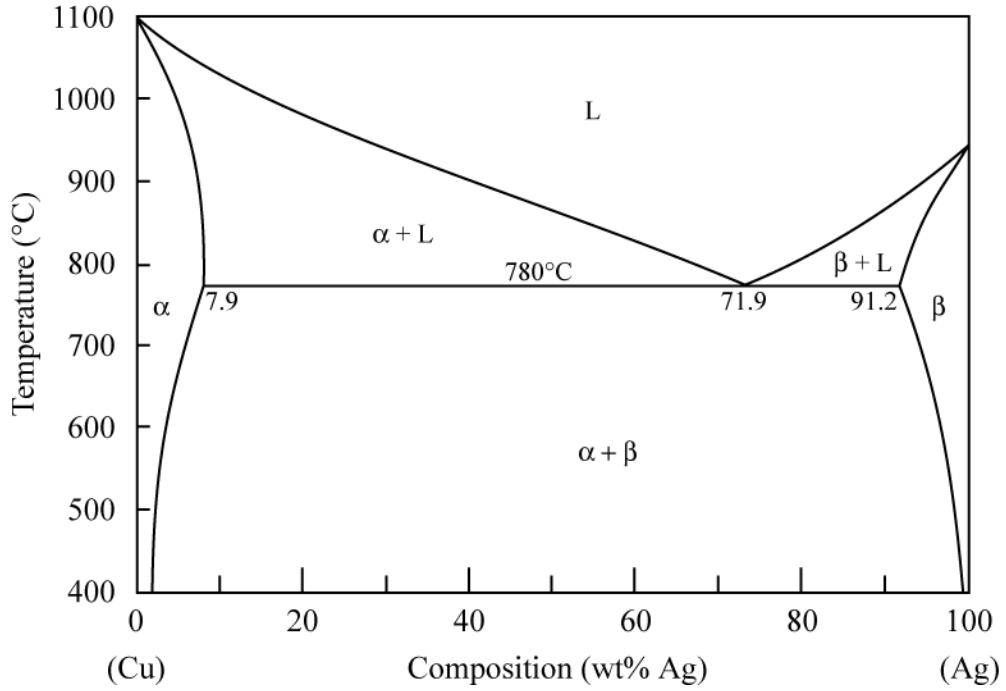
Homework #3
Due: 2/16/18

1. (20) (a) A mold cavity has the shape of a cube, 100 mm on a side. Determine the dimensions and volume of the final cube after cooling to room temperature if the cast metal is copper. Assume that the mold is full at the start of solidification and that shrinkage occurs uniformly in all directions. Copper undergoes 4.5% volumetric contraction upon solidification and shrinks 7.5% by volume during cooling to room temperature. (b) If the latent heat of copper is 209 J/gram, how many kWh of energy are generated during solidification of the cube?

2. (20) Refer to the phase diagram below. For an alloy of 20 wt% Ag/ 80 wt% Cu, name which phases are present, determine the composition and weight fraction of each phase at (a) 900°C and (b) 700°C. (c) Sketch what you would expect the microstructure to look like at 700°C?



3. (20) The left side of the Cu-Al and Al-Mg phase diagrams is similar in appearance to a binary eutectic. (a) Plot the composition of the solid for each alloy on the same graph as a function of distance (length fraction) for unidirectional solidification. Assume there is no diffusion in the solid and that any solute ejected during solidification is completely mixed with the remaining liquid. Don't worry about the last bit of solidification where the composition rises asymptotically. (b) Plot c_s/c_o for each alloy on the same graph as a function of length fraction to show the difference in their segregation behavior.
Cu-Al: c_o = 2 wt% Al, T_m(Cu) = 1085°C, T_E = 1035°C, c_{max} = 7.4 wt% Al, c_E = 8.5 wt% Al
Al-Mg: c_o = 10 wt% Mg, T_m(Al) = 660°C, T_E = 451°C, c_{max} = 14.9 wt% Mg, c_E = 35 wt% Mg

4. (20) A riser in the shape of a sphere is to be designed for a sand casting mold. The casting is a rectangular plate with length = 200 mm, width = 100 mm, and thickness = 18 mm. If the total solidification time for the casting is known to be 3.5 min, determine the diameter of the riser so that it will take 25% longer for the riser to solidify.

5. (20) Text problem 5.78.