ENGR-1600-01 Quiz 7 - 100 pts Prof. Lewis Name: _____

Some useful equations are given below:

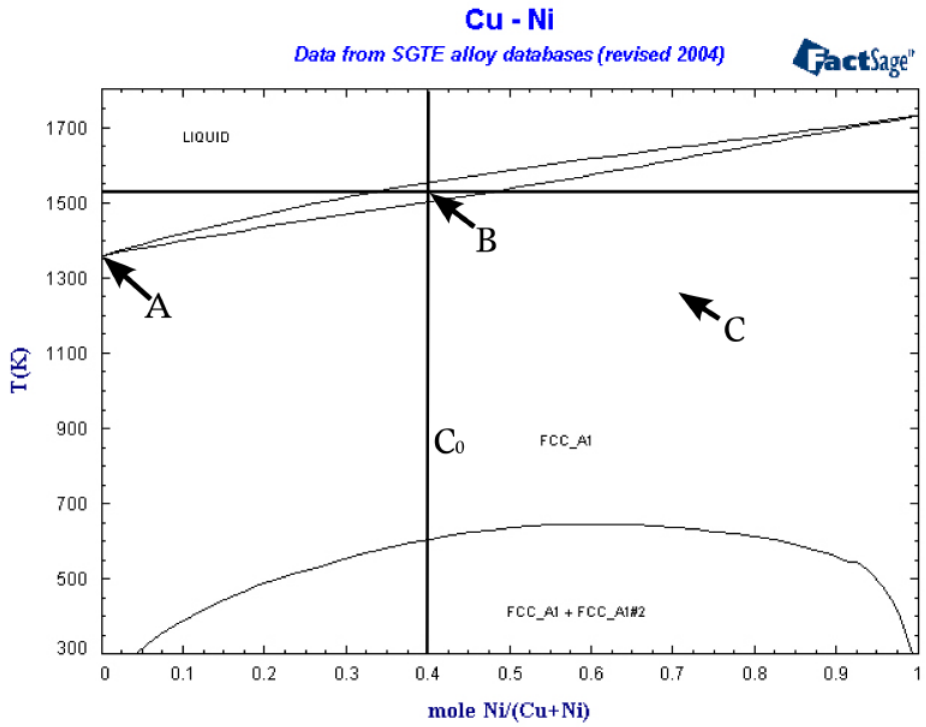
$$n\lambda = 2d\sin(\theta) \qquad d_{hkl} = \frac{a}{\sqrt{(h^2+k^2+l^2)}} \qquad N_A = 6.023 \cdot 10^{23} \qquad \rho = \frac{nA}{V_C N_A}$$

$$\sigma = \frac{F}{A_0} \qquad \sigma = E\epsilon \qquad \tau_{crss} = \sigma_y \cos\theta\cos\phi \qquad \nu = -\frac{\epsilon_x}{\epsilon_z} = -\frac{\epsilon_y}{\epsilon_z}$$

$$SC : a = 2R \qquad FCC : a = \frac{4R}{\sqrt{2}} \qquad BCC : a = \frac{4R}{\sqrt{3}} \qquad \mathbf{a}\cdot\mathbf{b} = |a||b|\cos\theta$$

$$\%CW = \frac{A_0 - A_f}{A_0} \cdot 100 \qquad K_{IC} = Y\sigma_c\sqrt{\pi a} \qquad \epsilon = \frac{l_i - l_0}{l_0} = \frac{\Delta l}{l_0}$$

$$N = N_0 \exp(-Q_v/(kT)) \qquad \text{P+F=C+2}$$



1. (20) Examine the Cu-Ni phase diagram. How many degrees of freedom are at point "A", "B" and "C"?

A. Using P+F=C+2 in each case... F = 0; 2 + F = 1 + 1

B. F = 1; 2 + F = 2 + 1

C. F = 2; 1 + F = 2 + 1

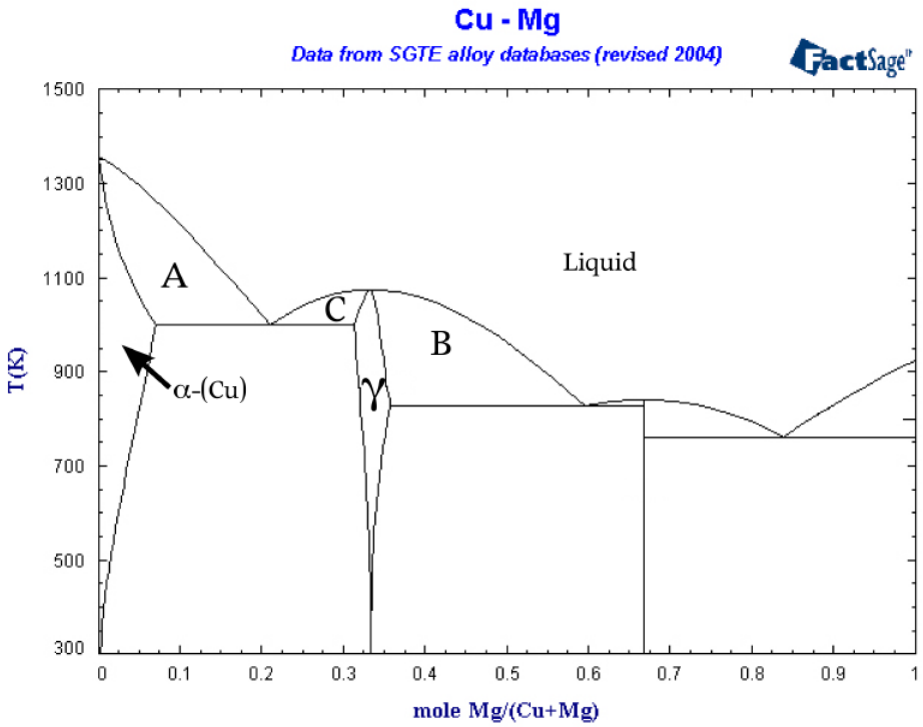
2. (20) Using the alloy composition C_0 identify the:

A. Alloy composition: 0.4 mol fraction Ni

B. The liquidus temperature: Approximately 1550K

C. The first temperature where there is 100% solid: Approximately 1500K

D. The mole fraction of solid phase: The system contains approximately (0.4-0.35)/(0.49-0.35) = 0.36 solid.



3. (20) Examine the Cu-Mg phase diagram. Label the phase fields at points "A", "B" and "C" with the correct number of phases and the phase identifications. What type of invariant reaction is at 0.2 mole fraction Mg and 1000K? How many phases are in equilibrium at this invariant point? Why is it called invariant? (6 words or less.)

A. Alpha + Liquid

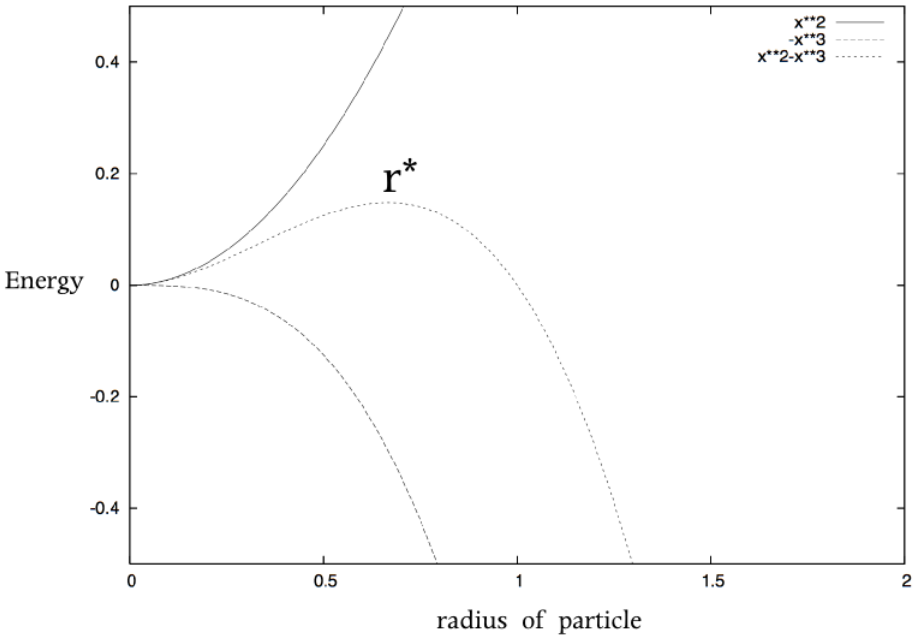
B. Gamma + Liquid

C. Gamma + Liquid

Number of phases in eqilibrium at 0.2 mole fraction Mg and 1000K
and name of invariant reaction. Three phases in equilibrium and the reaction is a eutectic.

Why is it called invariant? 0 DOF.

4. (20) Examine the three curves in the figure below. Why is one curve proportional to r-squared? Why r-cubed? What is the meaning of r* and what happens if a solid particle in a liquid has a radius less than r*?
The curve proportional to r^2 is related to the surface energy. The curve proportional to r^3 is related to the volume free energy. The sum of these two terms defines the critical radius for nucleation. If there is a thermal (or structural) fluctuation that produces a nucleus of a size greater than r* then that nucleus will be stable and continue to grow. If the particle (nucleus) has a size less than r* it will shrink. One can calculate the value of r* by taking the derivative of the equation that is represented by the r* curve. You know, of course, that when the derivative is zero, you have found the condition for r*.



5. (20) When a system is undergoing a phase change, the new phase must first nucleate then grow. Nucleation and growth are COMPETING events. Name one variable that affects this competition. For changes in the variable specified, how does the competition between nucleation and growth change?
Temperature. As T increases, growth rates increase at the expense of nucleation rates. As T decreases, nucleation rates increase at the expense of growth rates.