The University of Western Ontario
Department of Physics and Astronomy

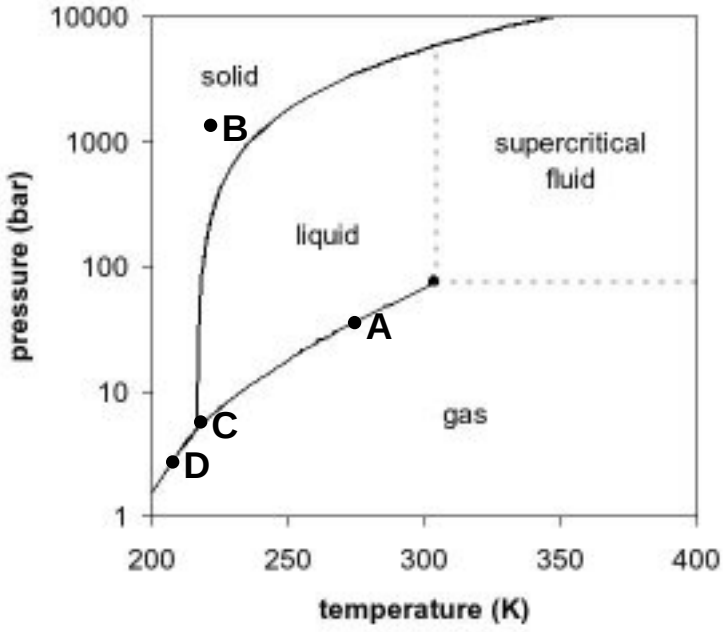
P2800 Fall 2008

Homework Assignment #4 (November 6, 2008)

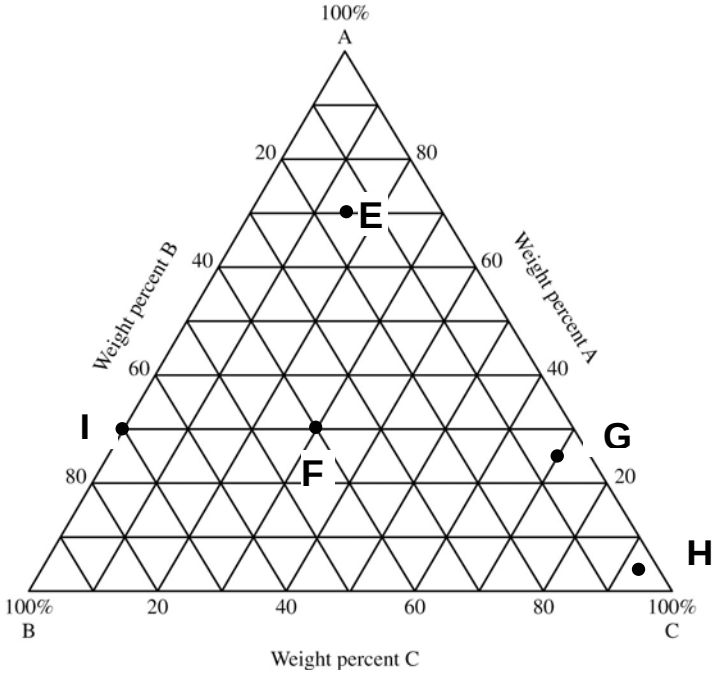
Due date November 18, 2008

Problems:

1. In the pure CO_2 equilibrium phase diagram (see below), how many components, phases, and degrees of freedom are there at points A, B, C and D (1 point).



2. Determine the weight percents of elements A, B and C for a ternary alloy at points E, F, G, H, I (1 point).

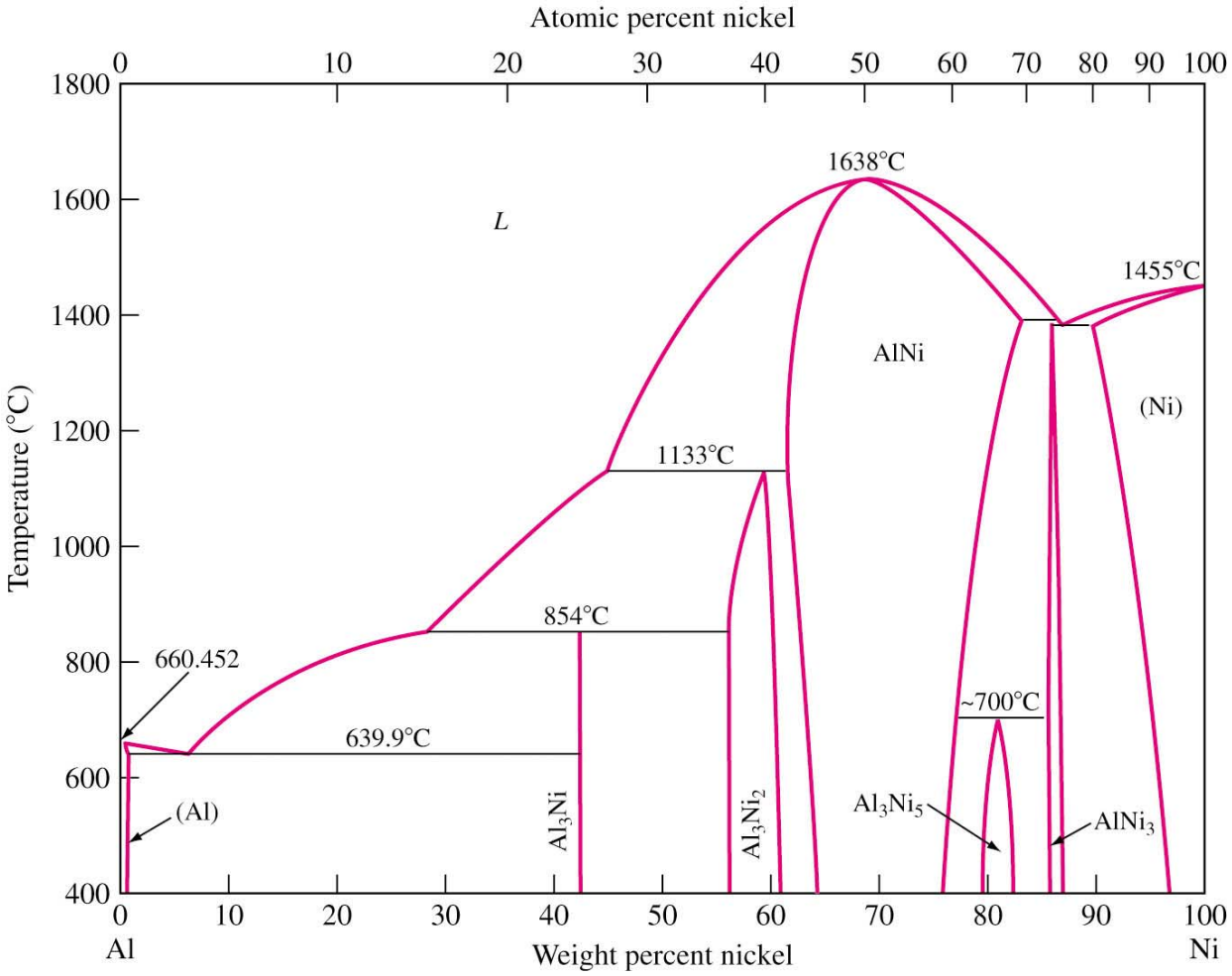


3. Consider the aluminum –nickel (Al-Ni) phase diagram below. For this phase diagram:

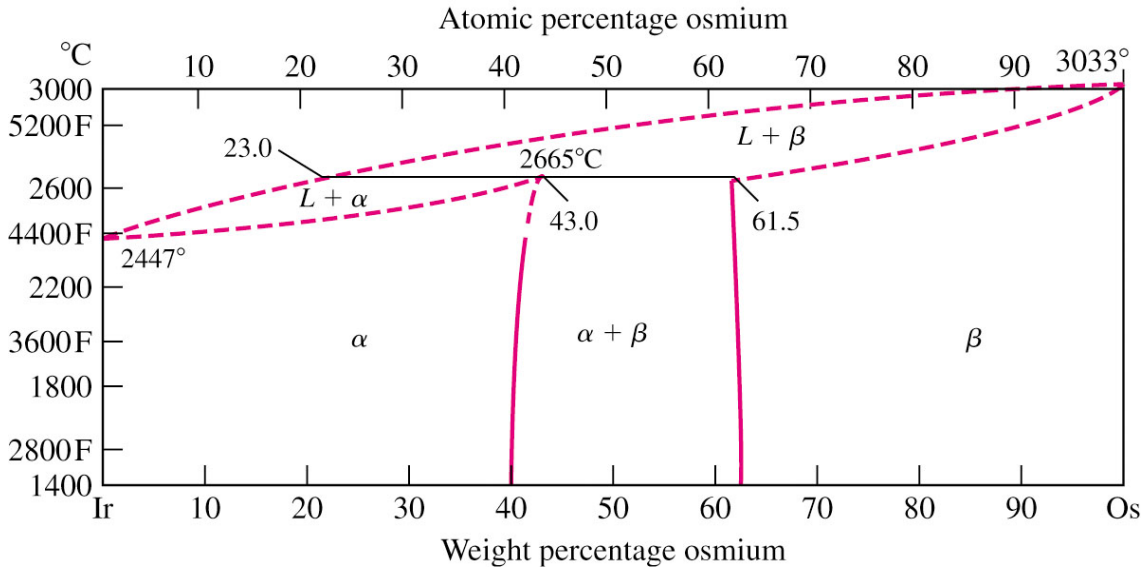
(a) Determine the coordinates of the **composition** and **temperature** of the invariant reactions. (Hint: there should be 6 of them)

(b) Write the <u>equations</u> for the three-phase invariant reactions and name them.

(c) Label the **two-phase** regions in the phase diagram. For example, two phases Al + Al_3Ni coexist in the region between ~2% -43% Ni and at T=400-639.9°C (2 points).



4. Consider the binary peritectic iridium-osmium phase diagram below. Make phase analyses of a 70 wt % Ir–30 wt % Os at the temperatures:
(*a*) 2600°C, (*b*) 2665°C + Δ*T*, and (*c*) 2665°C - Δ*T* .
In the phase analyses include:
(i) The phases present
(ii) The chemical compositions of the phases
(iii) The amounts of each phase
(iv) Sketch the microstructure by using 2 cm diameter circular field. (2 points).

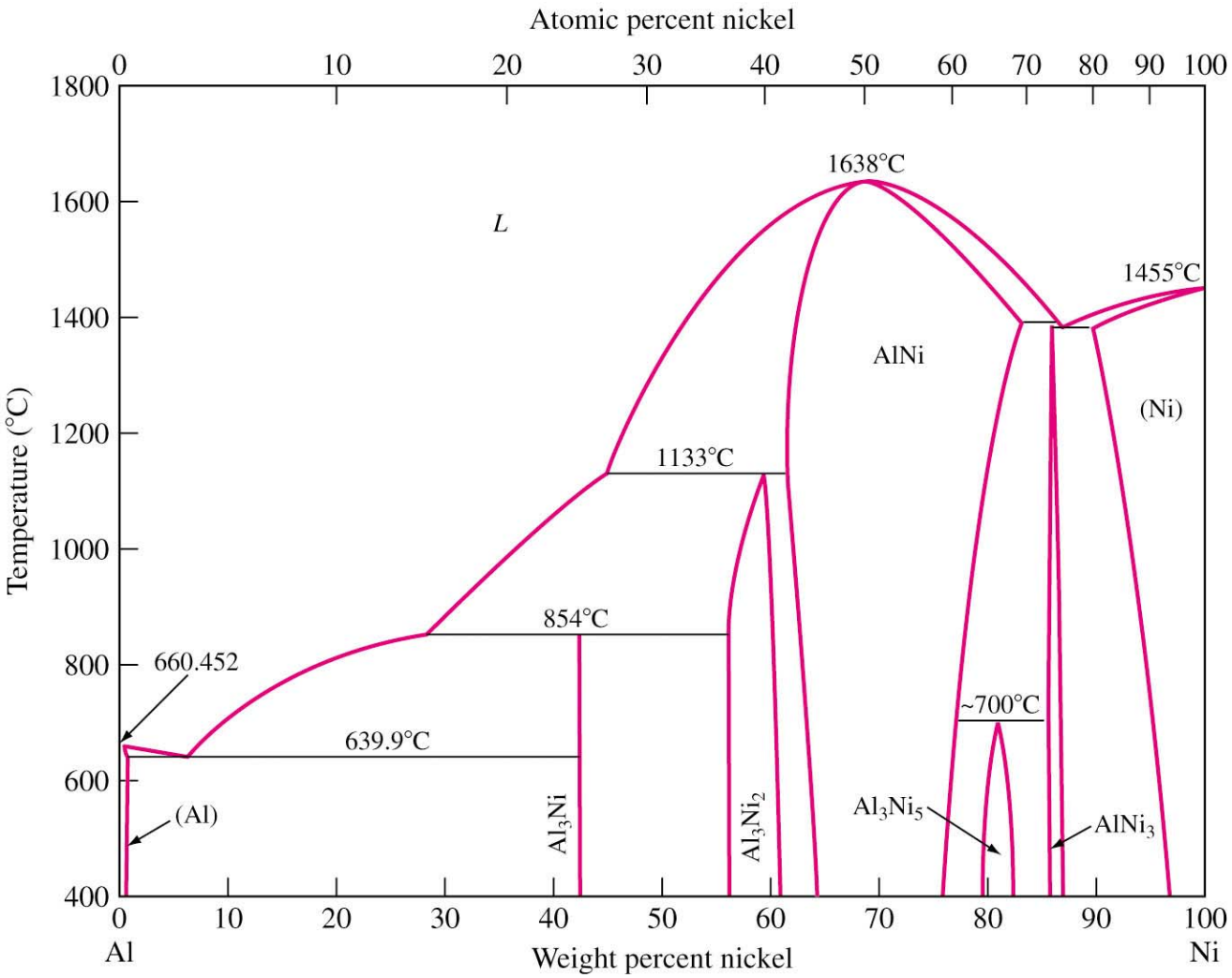


5. Define the following phases that exist in the Fe-Fe_3C phase diagram: (*a*) austenite, (*b*) α ferrite, (*c*) cementite, (*d*) δ ferrite (1 point).

6. A 0.25 percent C hypoeutectoid plain-carbon steel is slowly cooled from 950°C to a temperature just slightly *below* 723°C.
(*a*) Calculate the weight percent proeutectoid ferrite in the steel.
(*b*) Calculate the weight percent eutectoid ferrite and weight percent eutectoid cementite in the steel (1 point).

7. Give two composition examples of shape memory alloys (SMA). Using *Temperature vs Load* plot describe the changes in SMA shape and structure under different load and temperature conditions (1 point).

8. Calculate the critical (minimum) radius ratio r/R for octahedron coordination (CN = 6) of anions of radii R surrounding a central cation of radius r in an ionic solid (1 point).


Atomic percent nickel
0
10
20
30
40
50
60
70
80
90
100
1800
1600
1400
1200
1000
800
600
400
Temperature (°C)
1638°C
L
1455°C
AlNi
(Ni)
1133°C
854°C
660.452
639.9°C
~700°C
(Al)
Al3Ni
Al3Ni2
Al3Ni5
AlNi3
Al
Ni
Weight percent nickel