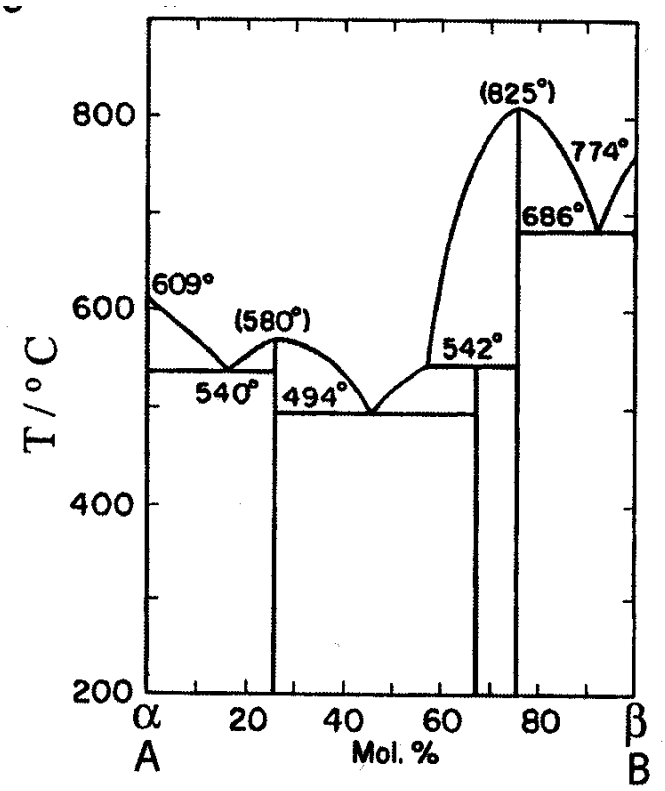
Theme: Phase diagrams

Task 1

Assume that the phases in the binary diagram under in Fig. 1. has such a minor solid solubility that they can be represented by lines in the phase diagram.



Figur 1.

(a) Put names on the phases and show what phases that are in equilibrium in the different areas of the phase diagram.

Mark the points for invariant reactions.

(b) Sketch and comment the cooling curve (temperature as function time) for a sample with overall composition of 65 mol% B. Assume that the sample is in equilibrium during the whole cooling process.

(c) What invariant reactions exists in Figure 1. Give arguments for your answer.

Task 2

Sketch a binary phase diagram that contains *one* of each of the following reactions: eutectic, peritectic, monotectic, eutectoid, peritectoid.

Task 3

(a) Neodym (Nd) exists in multiple crystalline modifications. What is this phenomenon called?

(b) One of the three crystalline modifications that Neodym can take is stable at high pressures, another is stable at high temperature.

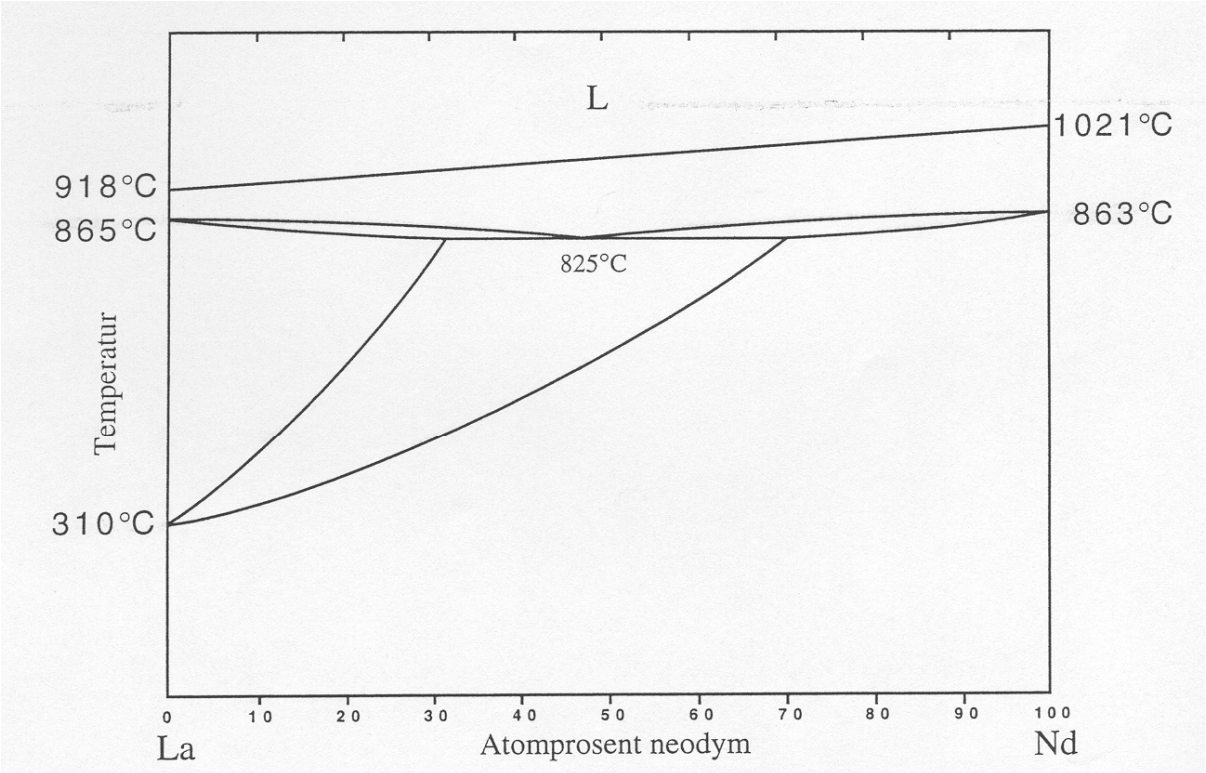
Sketch a (p, T) phase diagram for Nd.

(c) The figure below shows La – Nd.

Identify the one-phase areas.

Describe invariant phase reactions (P + F = C + 1)

Comment on liquidus/solidus.



Figur 2. Fasediagram for systemet La–Nd. (L angir stabilitetsområdet til smelten.)

Task 4

A binary phase diagram with the components A and B have the following features: The end phase, α, dissolves maximum 10% B, while the other end phase, β, dissolves maximum 15% A. The phase γ with average composition A_2B have very low solid solubility and melts incongruently at 1050 K. At $x_B = 0.6$ and T = 850 K there is an eutecticum. The phase α melts at 1250 K for $x_B = 0$ and phase β melts at 1300 K for $x_B = 1$.

(a) Sketch the phase diagram. Mark the phases that are in equilibrium in the different areas of the phase diagram.

(b) Consider the isopleth through xB = 0.75 in the binary system above. Sketch the cooling curve (temperature on the y-axis and time on the x-axis) for the isopleth. Assume equilibrium through the whole course. Start at a temperature above the liquidus curve and end at a temperature below the solidus curve. Use the condense phase rule to describe important features of the evolution of the curve.

Task 5

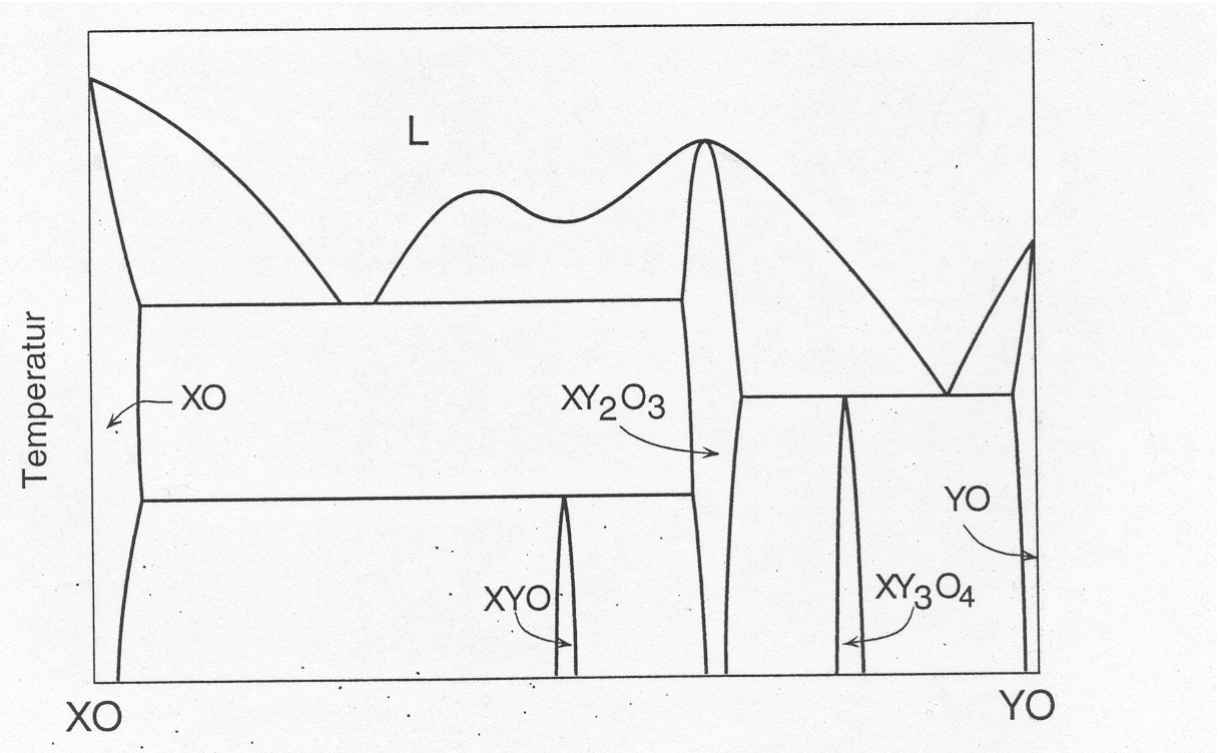
(a) Sketch a two-component phase diagram with fully solid solubility between the end phases.

Describe how the unit cell volume varies for such a phase with solid solubility.

What factors are or importance for the extension of solid solubility in a given system?

(b) Consider a hypothetical binary oxide system $AO_2 – B_2O_3$ with an incongruently melting phase, AB_2O_5. Assume that there is no solid solubility. Sketch the phase diagram.

(c) In the phase diagram under, there are some errors (or rather special situations). Mark these on the figure and discuss these in relation to the phase rule.



Figur 3: Fasediagram med feil (eller usannsynlige faseforhold).

Task 6

(a) Examine the appended phase diagram for the system aluminium – manganese. Mark all one-phase areas on the diagram.

(b) The phase diagram Al – Mn show many reactions that thermodynamically shall proceed at a constant temperature. Give **one** example of each principally different types that you find represented in the phase diagram.

(c) In the binary system A – B there are following phases and relations:

Phase α with 0 weight% B melts at 1065 °C. The maximum solubility of component B is 4 weight % at 500 °C.

Phase β contains 6 weight % B and have neglectable solid solubility. It is stable between 450 and 250 °C.

Phase ζ have maximum homogeneity range from 7 to 12 weight % B, and forms from α ant melt at 500 °C.

Phase δ melts congruently at 420 °C and is stoichiometric with 37.5 weight % B.

The phases ε and η forms peritectic at respectively 310 and 250 °C. Both are stoichiometric phases and contain 54.5 og 70.6 weight % B, respectively. The phase η is not stable below 100 °C.

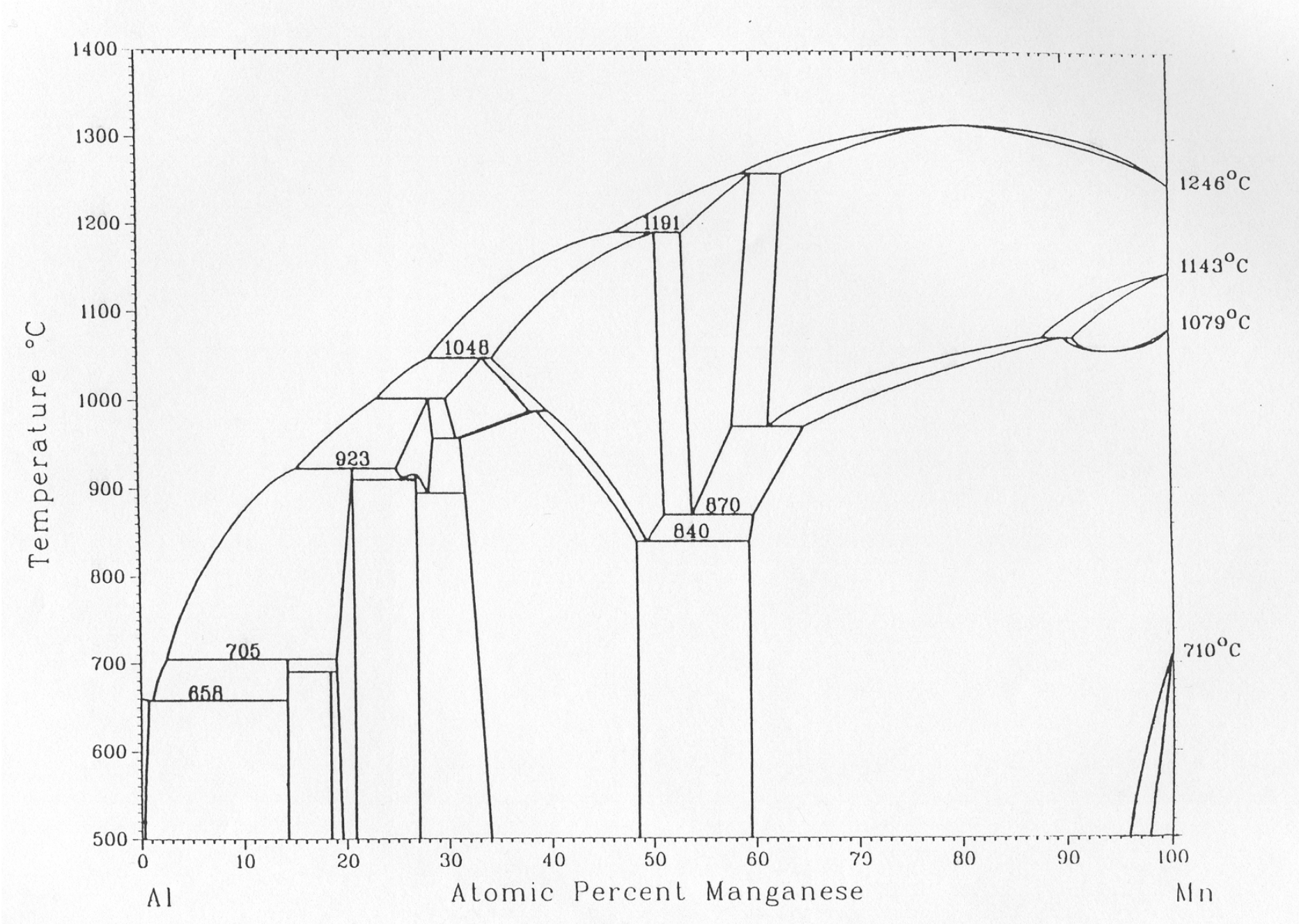
Phase θ is almost free of component A and melts at 230 °C.

There are two eutectica in the system. One has ha melt with composition of 20 weight % B at 280 °C. The other has a melt with 90 weight % B at 220 °C.

Use the data above to draw the phase diagram.

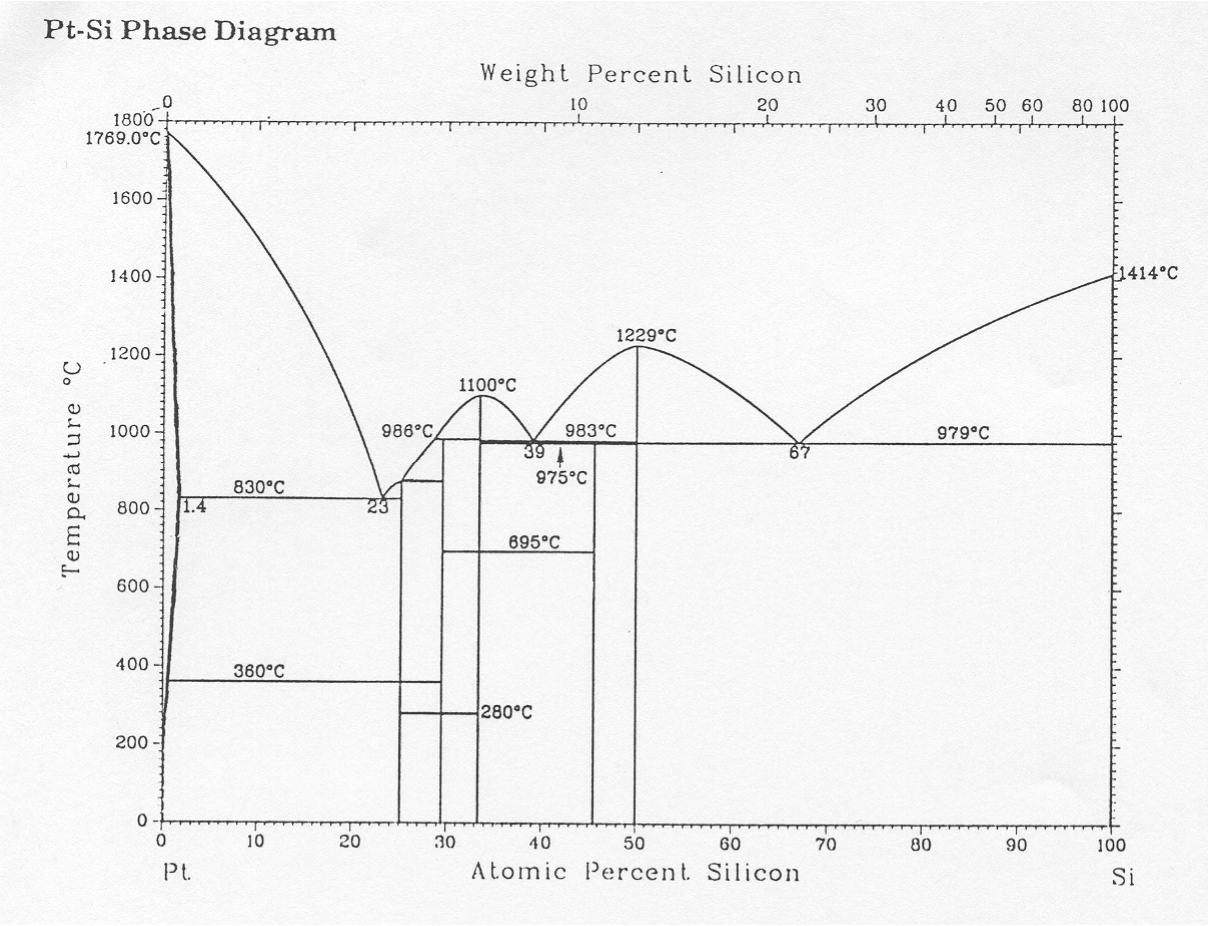
(d) A sample with 50 weight% B is in equilibrium at room temperature. What phases does the sample contain, and what are their ratios?

(e) Given that the components A and B are pure elements with atomic weights of respectively g/mol. Find formulas for the stoichiometric phases δ, ε og η.


1400
1300
1200
1100
1000
900
800
700
600
500
Temperature °C
0
10
20
30
40
50
60
70
80
90
100
Al
Atomic Percent Manganese
Mn
1246°C
1143°C
1079°C
710°C
1191
1048
923
870
840
705
658

Task 7

(a) The figure below shows the phase diagram for Pt – Si. Name the single-phases, and describe what happens at all invariant reactions (P + F = C + 1).

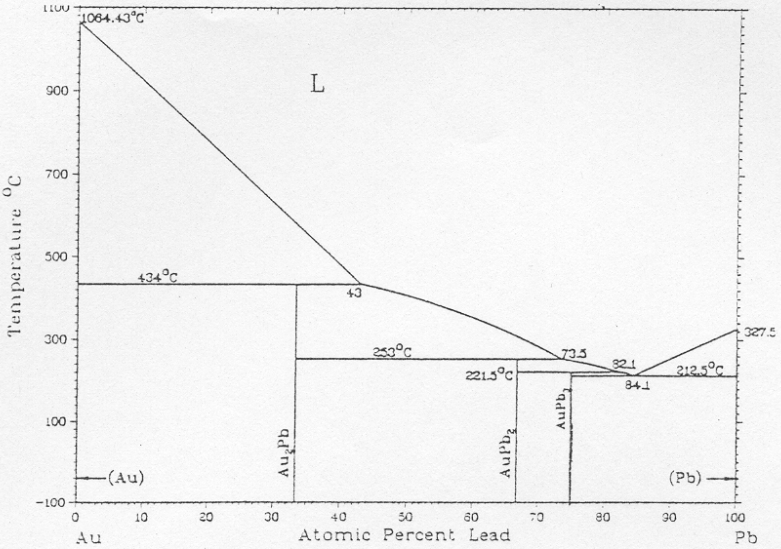


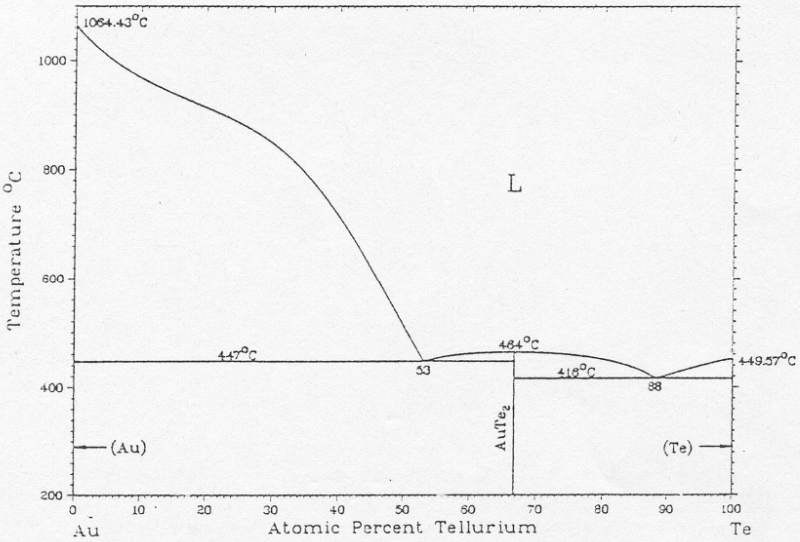
Task 8

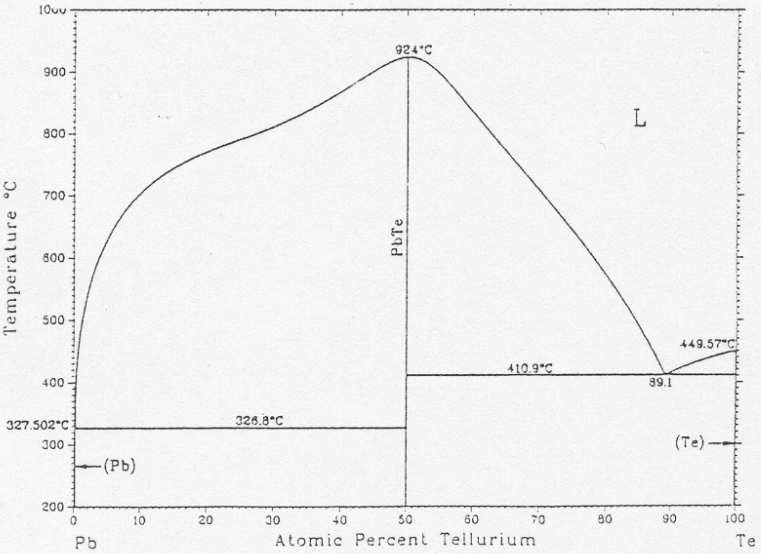
The figure below shows the phase diagram for the binary systems Au – Pb, Au – Te and Pb – Te.

(a) Discuss shortly all invariant reactions (in relation to the condensed phase rule).

(b) What does a sample with composition $Au_{60}Te_{40}$ contain at room temperature (assume equilibrium)? Give the ratios of the phases in mol% and weight%. (Atomic masses: Au = 196.97 g/mol, Te = 127, 60 g/mol).


1064.43°C
L
434°C
43
253°C
73.5
32.1
221.5°C
84.1
212.5°C
327.5
Au2Pb
AuPb2
AuPb3
(Au)
(Pb)
Temperature °C
Au
Atomic Percent Lead
Pb


1064.43°C
L
447°C
53
484°C
418°C
88
449.57°C
AuTe2
(Au)
(Te)
Temperature °C
Au
Atomic Percent Tellurium
Te


924°C
L
PbTe
449.57°C
410.9°C
89.1
327.502°C
326.8°C
(Pb)
(Te)
Temperature °C
Pb
Atomic Percent Tellurium
Te