

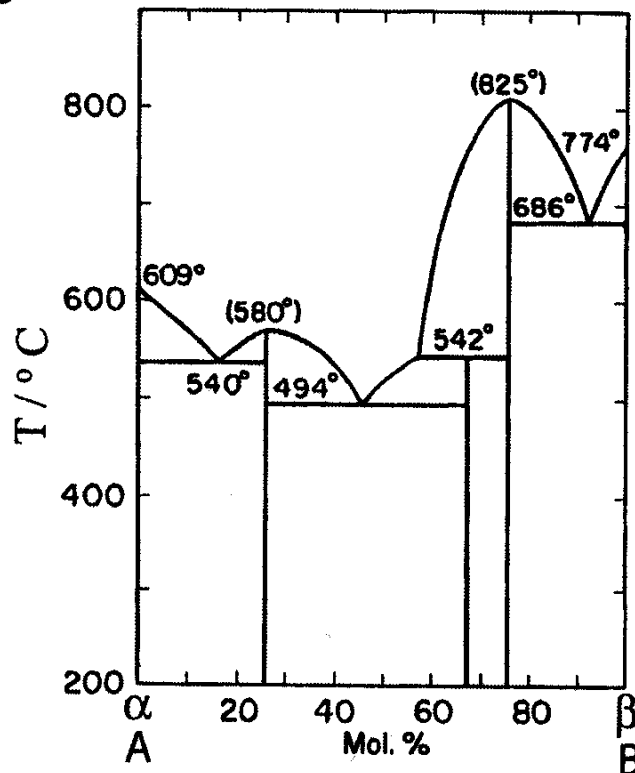
Sett 5

Theme: Phase diagrams

The tasks are cut from earlier exams.

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 Figur 1. Argument for your answer.

Task 2

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 A₂B have very low solid solubility and melts incongruently at 1050 K. At $x_B = 0.6$ and $T = 850$ K there is an eutectic. The phase α melts at 1250 K for $x_B = 0$ and phase β melts at 1300 K for $x_B = 1$.

- Sketch the phase diagram. Mark the phases that are in equilibrium in the different areas of the phase diagram.
- Consider the isopleth through $x_B = 0.75$ 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 condensed phase rule to describe important features of the evolution of the curve.

Task 3

- Examine the appended phase diagram for the system aluminium – manganese. Mark all one-phase areas on the diagram.
- 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.
- 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 has negligible solid solubility. It is stable between 450 and 250 °C.

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

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

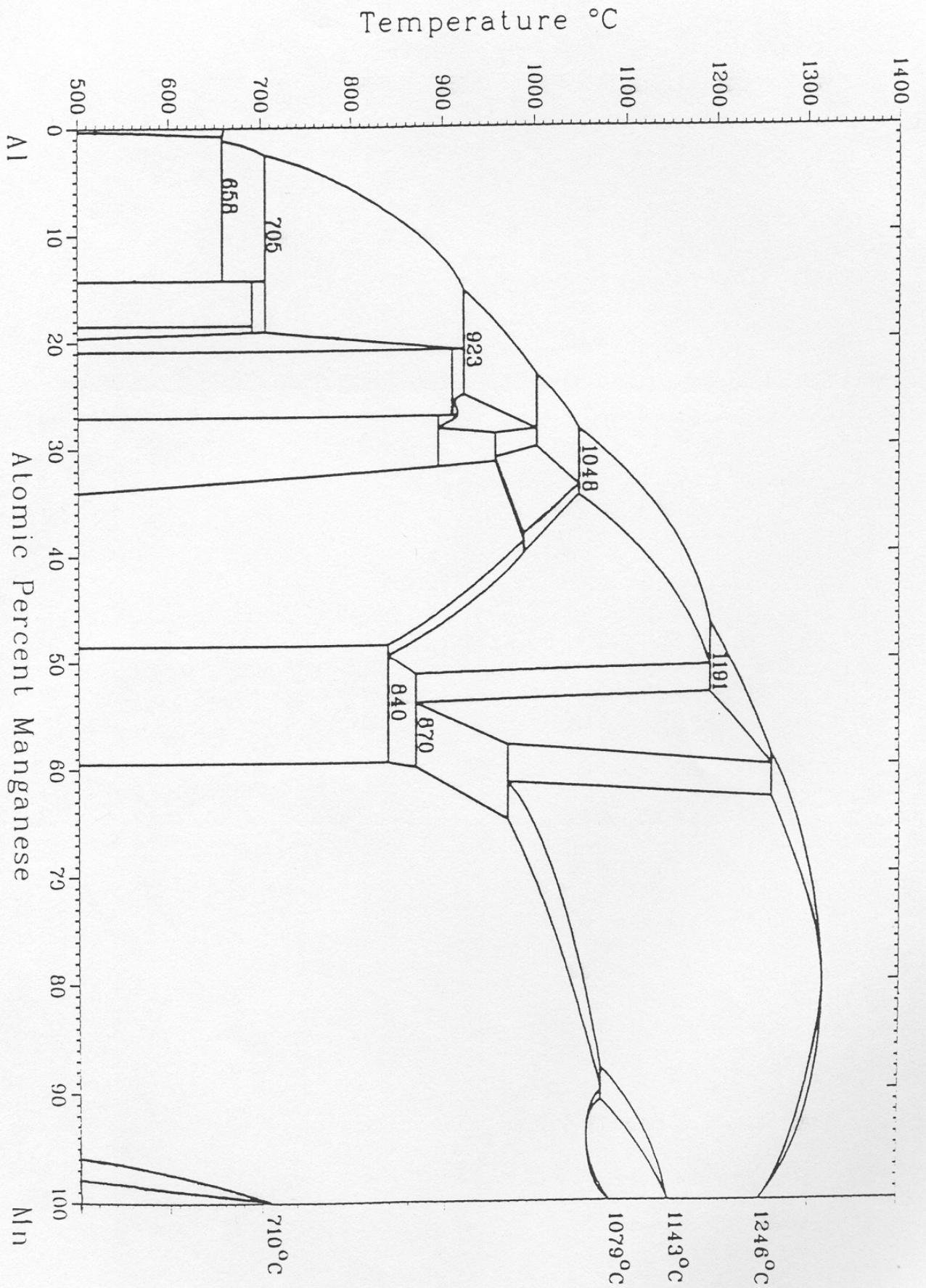
The phases ϵ and η form peritectic at respectively 310 and 250 °C. Both are stoichiometric phases and contain 54.5 and 70.6 weight % B, respectively. The phase η is not stable below 100 °C.

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

There are two eutectica in the system. One has a 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 how large ratio of the sample are these phases?
- (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 .



Oppgave 4

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

Oppgave 5

- (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.

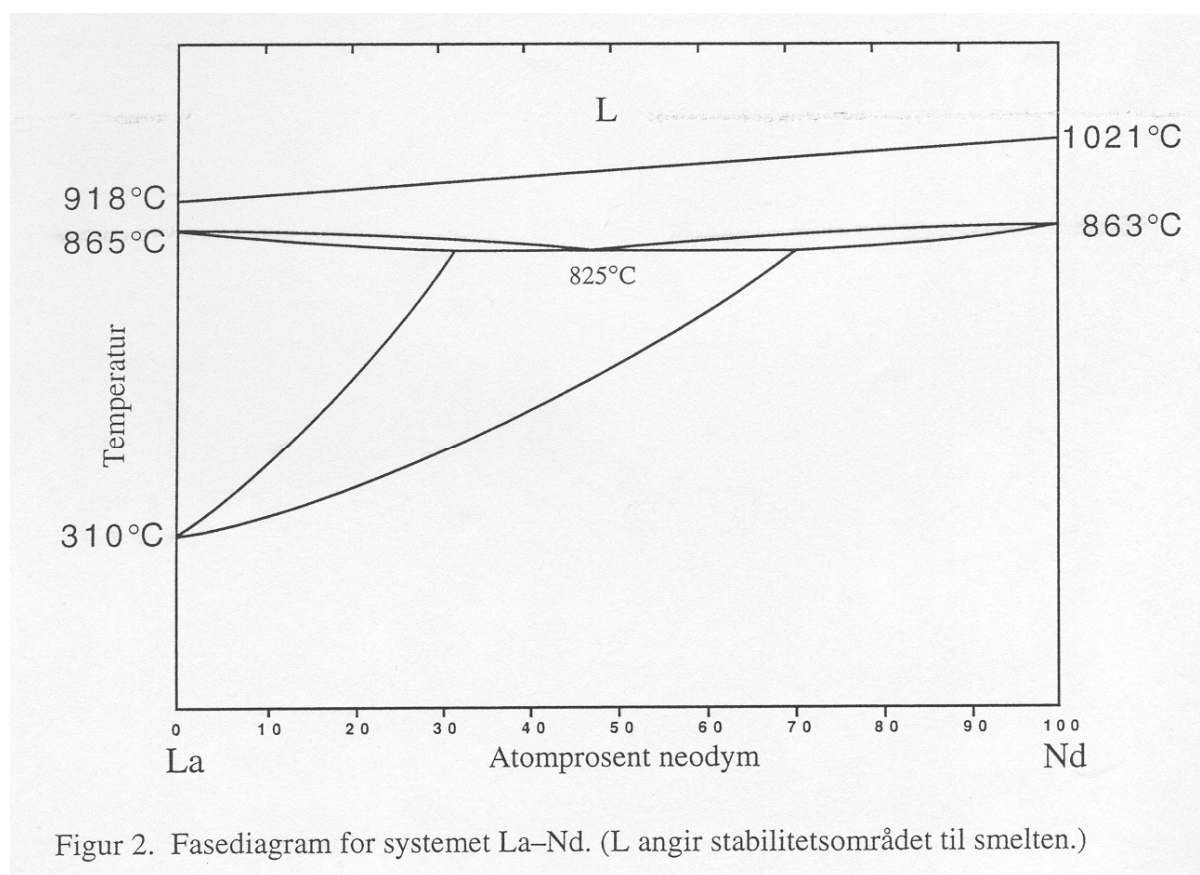
Sketch a (p, T) phase diagram for Nd.

- (c) The figure below shows La – Nd.

Identify the one-phase areas.

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

Comment on liquidus/solidus.



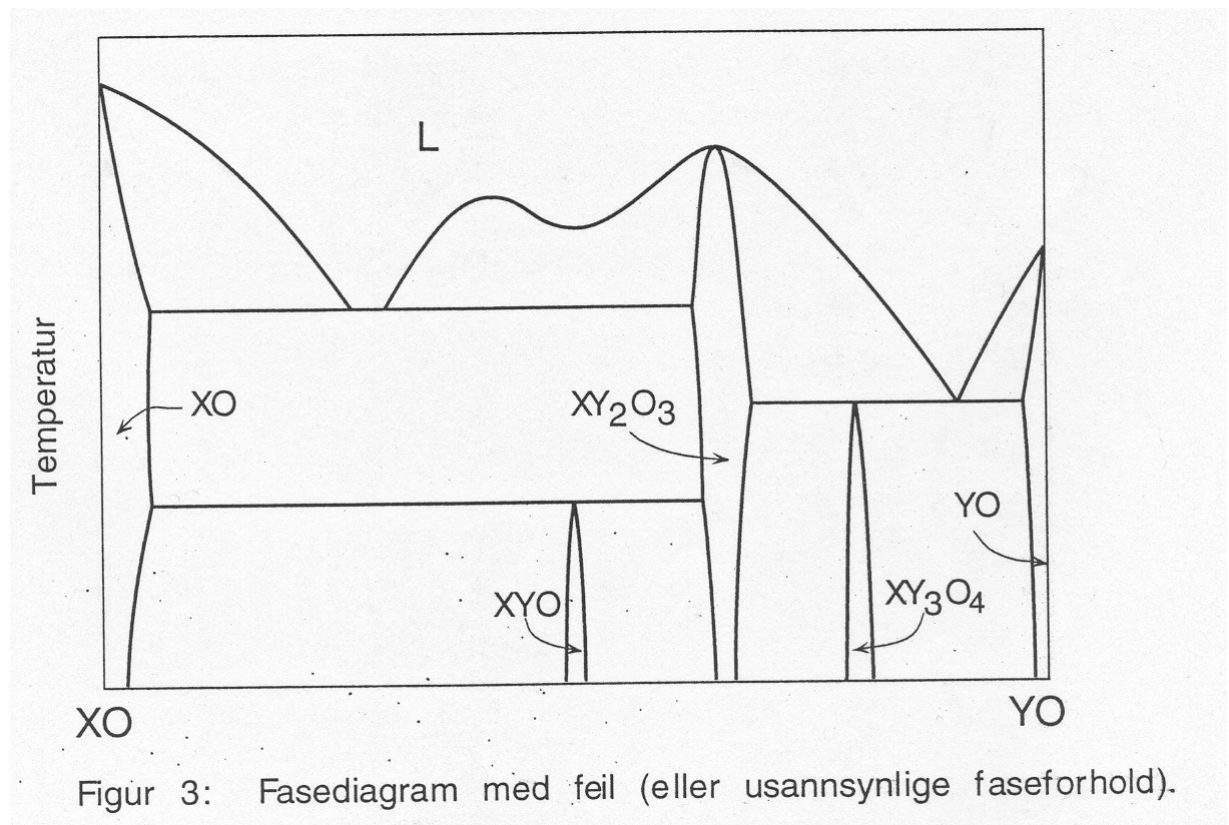
Oppgave 6

- (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.

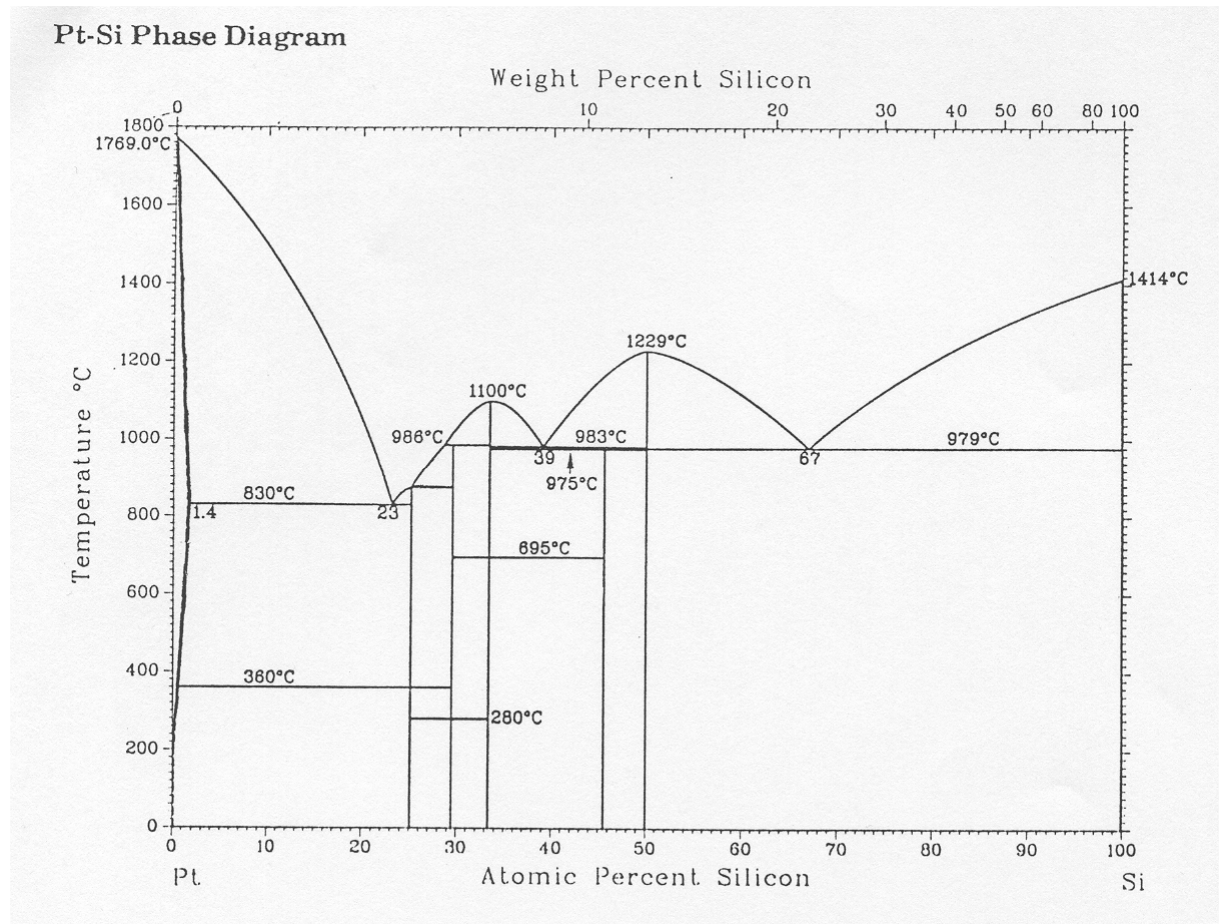
What factors are of importance for the extension of solid solubility in a given system?

- (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.



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 og Pb – Te.

- (a) Discuss chortly all invariant reactions (in relation to the condensed phase rule).
- (b) What does a sample with composition $\text{Au}_{60}\text{Te}_{40}$ 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).

