UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2007/2008

October/November 2007

EBB 512/3 - Phase Diagram & Phase Equilibra

Duration : 3 hours

Please ensure that this examination paper contains SEVEN printed pages and ONE page APPENDIX before you begin the examination.

This paper contains SIX questions.

Instructions: Answer any **FIVE** questions. If a candidate answers more than five questions, only the first five answers will be examined and awarded marks.

Answer to any question must start on a new page.

All questions must be answered in English.

1. [a] Calculate the amount of each phase present in a 1-kg alumina refractory with composition 70 mol % Al_2O_3 - 30 mol % SiO_2 at:

(i) 2000°C

(ii) 1900°C and

(iii) 1800°C (Figure 1)

Take O = 16 amu, Al = 26.98 amu and Si = 28.09 amu.

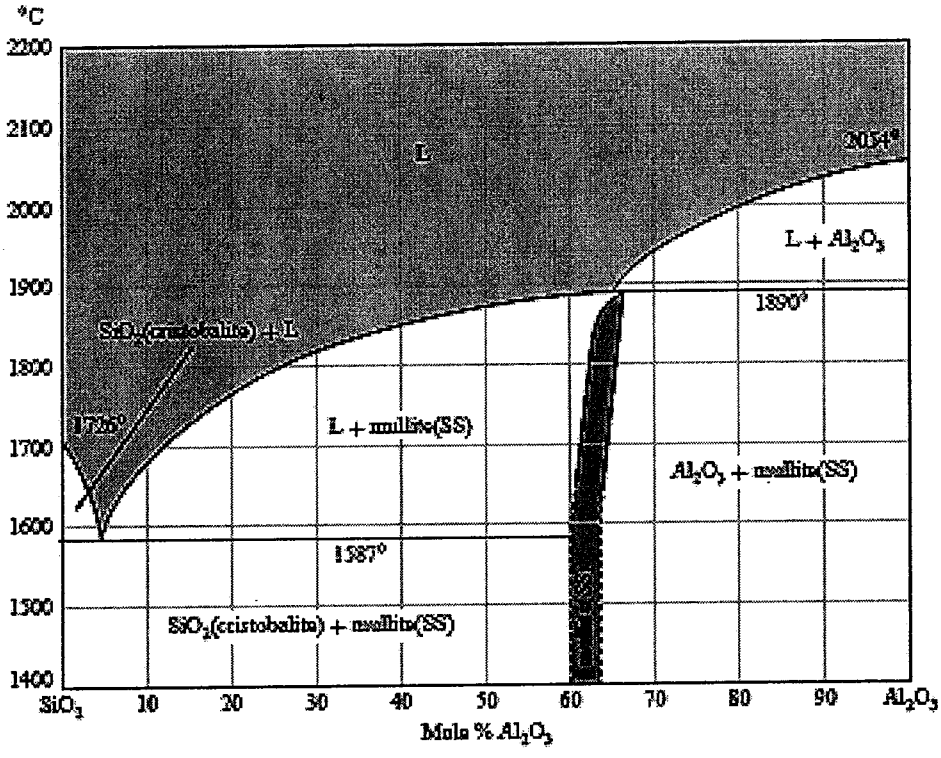

Figure 1

(50 marks)

2. [a] Explain the mechanical mixture and solutions with aid of diagrams.

(50 marks)

[b] The following equilibrium data were determined for the reaction.

$$NiO_{(s)} + CO_{(g)} = Ni_{(s)} + CO_{2\,(g)}$$

Assuming; $\Delta G^\circ = -RT\ln K$, where G° standared Gibbs free energy and K = equilibrium constant = $[a_{Ni}\, xP_{CO2}]/[a_{NiO} xP_{CO}]$, a is the activity

$T^\circ C$	663	716	754	793	852
$Kx10^{+3}$	4.535	3.323	2.554	2.037	1.577

(i) Find K, ΔG°, ΔH° and ΔS° at 1000K by using a plot.

(ii) Would an atmosphere of 15%CO_2, 5%CO and 80%N_2 oxidies Ni at 1000K.

(50 marks)

3. At 1073K the partial excess free energy for the reaction Zn(l) = Zn:Cu(α) is given In J g $atom^{-1}$ by

$$RT \ln \Gamma = -20{,}920 + 26{,}359\, X_{zn}/X_{Cu}.$$

(a) Find the vapour of zinc over the solid alloy containing 25 at % Zn at this temperature. Where Γ activity Coefficient, X fractional composition.

(50 marks)

(b) If the α/α+β phase boundary at 1073K occurs at 30 at % Zn and the conjugate alloy in the β phase field contains 38 at % Zn, find the activity coefficient of Zn in this latter alloy relative to solid Zn.

For pure Zn

$$\log P_{zn(s)} = [-6850/T] - 0.755 \log T + 8.36$$
$$\log P_{zn(l)} = [-6620/T] - 1.255 \log T + 9.46$$

Where P is a pressure in atm and T is the temperature.

(50 marks)

...5/-

4. ABC ternary system forms three binary eutectics and a ternary eutectic as shown below, Figure 3. Discuss equilibrium cooling paths for the overall compositions p, q and r indicated in the diagram. Discuss also the change in microstructure that should occur during cooling.

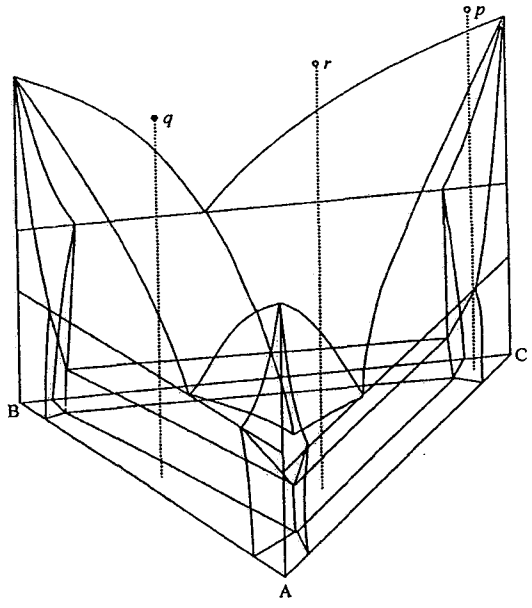

Figure 3

(100 marks)

5. With reference to the Figure 4

(a) State what surfaces enclose the following phase regions:

(i) L + α + β

(ii) L + α

(50 marks)

(b) State what phase regions are separated by the surface:

(i) $OGFO_2$;

(ii) MNO;

(iii) NGO.

(50 marks)

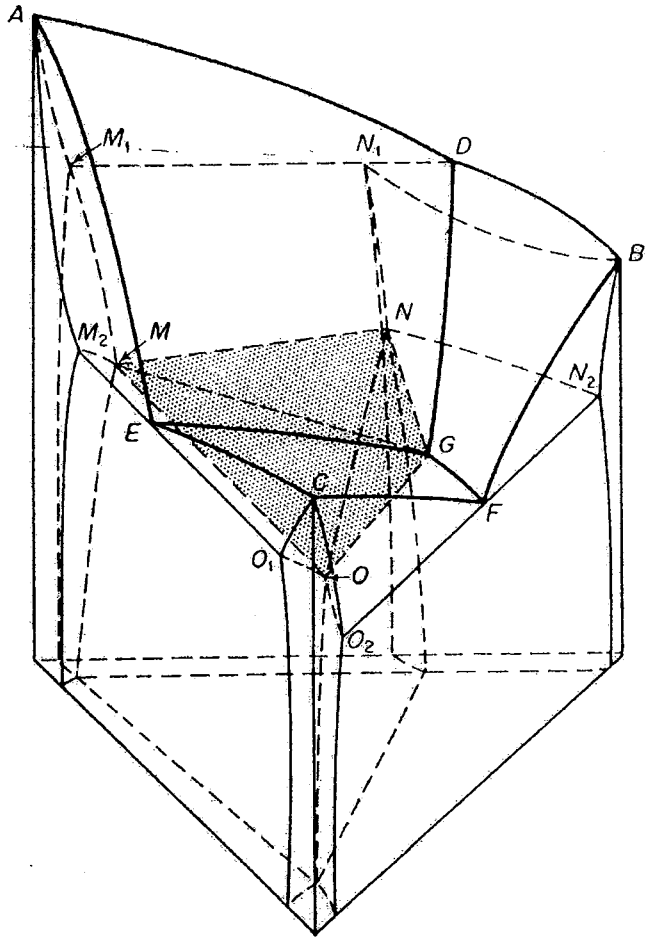

Figure 4

6. A ternary system ABC shows complete liquid solubility and partial solid solubility, forming primary solid solutions α, β and γ, based on A, B, and C, respectively. System BC contains a peritectic reaction (liquid + β = δ) at 800°C, in which δ is an intermediate phase containing 40% C,

The ternary system contains two invariant reactions as follows:

Temperature	Liquid composition	Solid phases involved
650°C	30%A, 32%B, 38%C	α, β, δ
620°C	37% A, 8%B, 55% C	α, δ, γ

The solid solubility ranges of α, β, γ and δ are very small (< 1 %).

Draw:

(i) a liquidus projection for the system consistent with the data, and state the nature of the reactions shown;

(ii) an isothermal section corresponding to a temperature of 600°C.

(100 marks)

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[EBB 512]

APPENDIX