UNIVERSITY OF JOHANNESBURG

PROGRAM	:	SSA NATIONAL DIPLOMA *ENGINEERING METALLURGY*
SUBJECT	:	**PRODUCTION OF IRON AND STEEL 4**
CODE	:	**PRS42-2**
DATE	:	SUMMER SSA EXAMINATION 2017 9 JANUARY 2017
DURATION	:	(SESSION 1) 08:00 - 11:00
WEIGHT	:	40 : 60
TOTAL MARKS	:	100

EXAMINER	:	DR X PAN
MODERATOR	:	M HENDERSON
NUMBER OF PAGES	:	4 PAGES

INSTRUCTIONS	:	ANSWER ALL QUESTIONS
REQUIREMENTS	:	CALCULATOR

QUESTION 1 (20 marks)

In South Africa various production processes are used to produce charge chrome, such as Outokumpu process, Premus process, conventional SAF process and DC plasma furnace process. Use I-P-O process model to answer the following questions:

1. Draw the process flow-sheet of Outokumpu process

2. Compare the conventional SAF process with Outokumpu process with 5 main differences

QUESTION 2 (20 marks)

Due to the shortage of electric energy in South Africa, how to improve energy efficiency is one of the major challenges faced in the local ferrochrome smelting industry. To help assess the feasibility study of energy saving, you are required to calculate the amount of energy that can be released from 20 tons of ferroalloy, after tapped from a SAF at 1600 C and then cooled to 500 C. See the thermodynamic data in table 1.

Table 1. Thermodynamic data for the ferroalloy (Fe)

Cp (Fe-a) =	14.1+29.7/1000*T + 1.8*100000*T^(-2)	J/ g atom/K, (300-1033K)
Cp (Fe-β) =	43.5	J/ g atom/K, (1033-1183K)
Cp (Fe-γ) =	20.3+12.55/1000*T + 1.8*100000*T^(-2)	J/ g atom/K, (1183-1674K)
Cp (Fe-δ) =	43.1	J/ g atom/K, (1674-1808K)
Cp (Fe-l) =	41.8	J/ g atom/K, (1808-3000K)
Lt(α to β) =	1720	J/g atom at 1033 K
Lt(β to γ) =	910	J/g atom at 1183 K
Lt(γ to δ) =	630	J/g atom at 1674 K
Lt(δ to l) =	16160	J/g atom at 1808 K

QUESTION 3 (60 marks)

Xstrata is one of the main producers of charge chrome in the world. At its Lion Plant, the No 4 furnace has behaved irregularly in the last 2 days since the change of some raw materials, such as high roof temperature and difficult to tap. It is required urgently to find out what are

the main causes and bring the furnace back to normal production. As a part of the cause-finding process, you are given the following tasks:

(1) Calculate the mass balance of the furnace in the period of last 2 days, find out any abnormal issues and propose your solutions

(2) Calculate the mass balance in each zone, using the 5-zone smelting model by Dr X Pan

Attached the details of various raw materials charged to the furnace in the last 2 days with production of 14 740 kg of ferrochrome:

40 000 kg ore
10 000 kg quartzite
5 980 kg coke

Attached also find the chemical compositions of materials/products of the furnace and the phase diagram of SiO2-MgO-Al2O3.

Table 1. Raw materials composition (weight %)

Name, %	Cr2O3	Fe2O3	FeO		MgO	SiO2	Al2O3	H2O	C
Ore	39	8	15		10	9	14	5	0
Quartzite	0	0	0		0	100	0	0	0
Coke	0	0	0		0	7	4	0	89

Table 2. Alloy and slag composition (weight %)

Name, %	Cr2O3	FeO	MgO	SiO2	Al2O3	Cr	Fe	C	Si
Slag	?	?	?	?	?	0	0	0	0
Alloy	0	0	0	0	0	53.84	35.78	7.19	3.19

Table 3. Atomic weight

Element	Fe	Cr	Si	Al	Mg	O	C	H
Weight	56	52	28	27	24	16	12	1

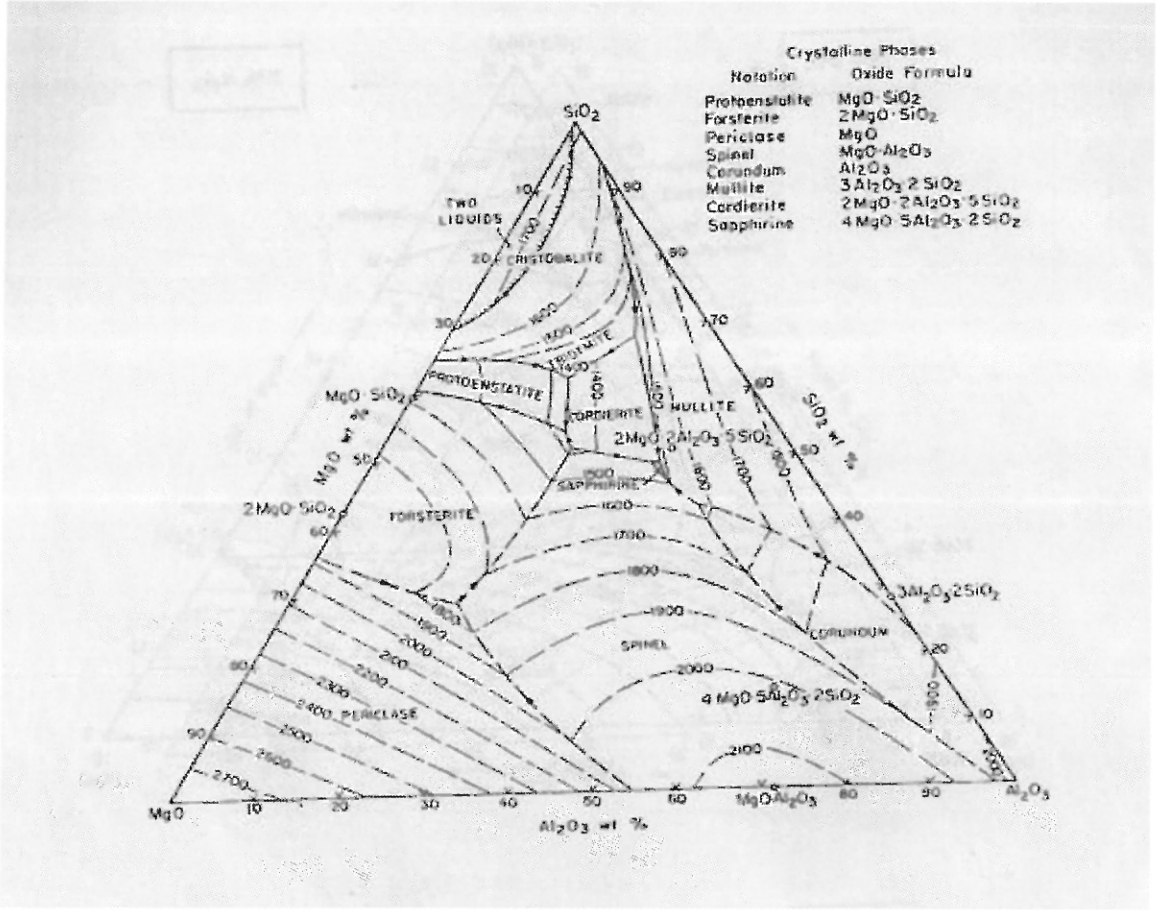

Figure 1. Phase diagram of SiO2-MgO-Al2O3

Total = 100