UNIVERSITY OF JOHANNESBURG

PROGRAM	:	MAIN EXAM FOR BTECH DEGREE *ENGINEERING METALLURGY*
SUBJECT	:	**PRODUCTION OF IRON AND STEEL 4**
CODE	:	**PRS42-2**
DATE	:	9 NOVEMBER 2019
DURATION	:	3 HOURS
WEIGHT	:	40 : 60
TOTAL MARKS	:	100

EXAMINER	:	DR X PAN
MODERATOR	:	K SEDUMEDI
NUMBER OF PAGES	:	4 PAGES

INSTRUCTIONS	:	ANSWER ALL QUESTIONS
REQUIREMENTS	:	CALCULATOR, RULER

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QUESTION 1 (20 marks)

A 4-element system of O-C-Fe-Cr is used widely to help understand the main chemical reactions that occur in the production of ferrochrome. Please answer the following questions:

1. Draw the diagram of O-C-Fe-Cr system used in the class lecture
2. Calculate the weight percentage values of O or C for all oxides or carbides
3. Place all oxides and carbides in the diagram of O-C-Fe-Cr system with the values of weight percentage of O or C.

QUESTION 2 (30 marks)

In the process of crushing and screening of casted ferrochrome, large amount of fines can be generated. To save the cost, the fines are considered being added in the liquid ferrochrome in the ladle so the fines can be melted and then casted again. It is required to determine the maximum of fines that can be added in term of fines-kg per ton of liquid alloy.

The ferrochrome is tapped from a SAF at 1680 °C and the temperature of ferrochrome fines is 25 °C. See the thermodynamic data in Table 1.

Table 1. Thermodynamic data for the ferroalloy

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

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QUESTION 3 (50 marks)

Assmang is one of the main producers of charge chrome in South Africa. At its Machadodorp works, the No 1 furnace behaved irregularly in the last 2 days. 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 and the 3-component-slag composition of SiO2-MgO-Al2O3 in weight percentage
(2) Find out any major abnormal issues and propose your solutions
(3) Calculate the mass balance in each zone using Dr Pan's 5-zone model

Attached see the details of various raw materials charged in the furnace in the last 2 days with production of 79 145 kg of ferrochrome:

190 000 kg ore
11 000 kg quartzite
34 600 kg coke

Attached see the chemical compositions of materials and metal product of the furnace in Table 2-3 and the phase diagram of SiO2-MgO-Al2O3 in Figure 1. The atomic weights of some elements are listed in Table 4.

Table 2. Raw material composition

Name	Cr2O3 %	Fe2O3 %	FeO %	MgO %	SiO2 %	Al2O3 %	H2O %	C %	Total %
Ore	39	8	15	10	9	14	5	0	100
Quartzite	0	1	0	1	97	1	0	0	100
Coke	0	0	0	0	9	2	4	85	100

Table 3. Alloy composition

Name	Cr	Fe	C	Si	Total%
%	54.38	35.16	7.30	3.16	100

Table 4. Atomic weight

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

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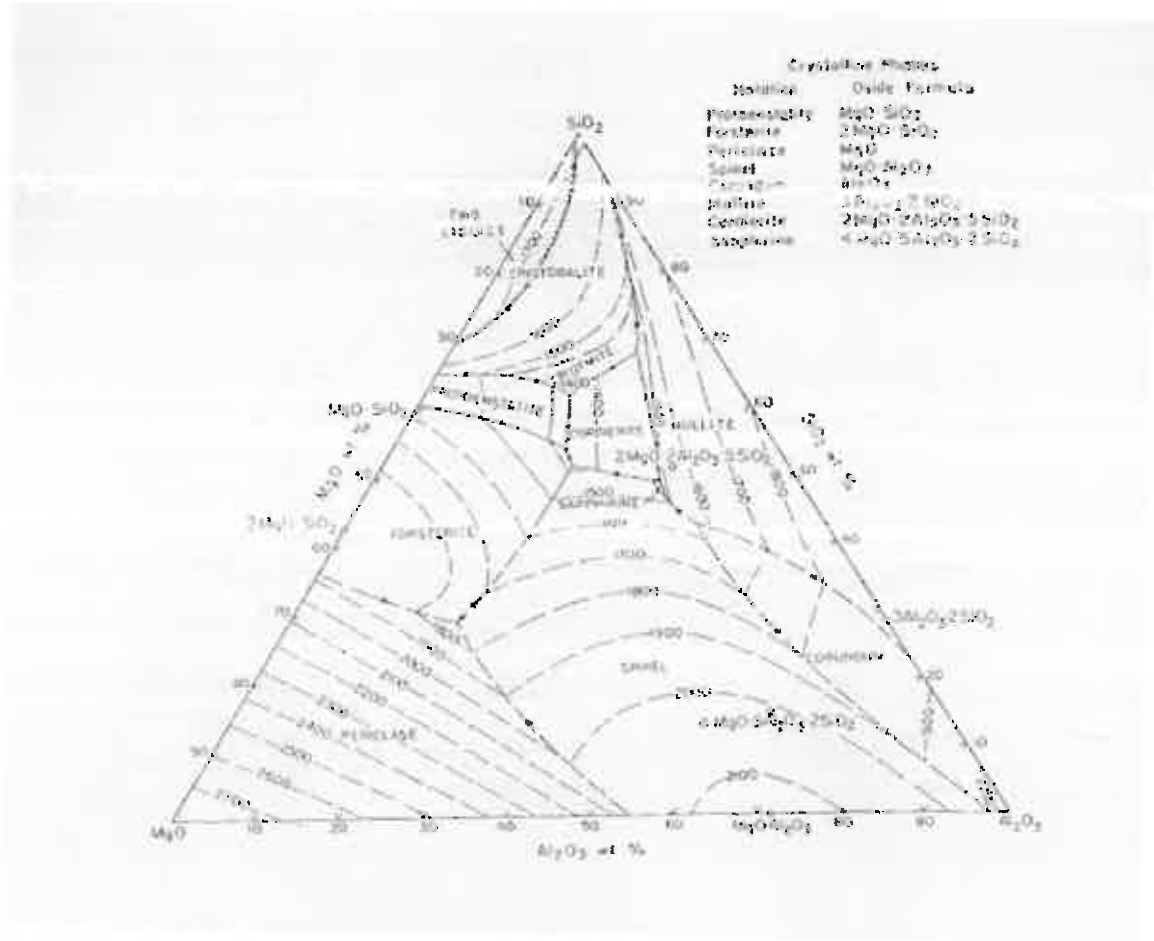

Figure 1. Phase diagram of SiO2-MgO-Al2O3

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