



**PROGRAM** : SSA EXAM FOR BENG DEGREE  
*EXTRACTION METALLURGY*

**SUBJECT** : FERROALLOY PRODUCTION

**CODE** : FAPMT 3B

**DATE** : 16 JANUARY 2020

**DURATION** : 08:30 - 11:30

**WEIGHT** : 40 : 60

**TOTAL MARKS** : 100

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**EXAMINER** : DR X PAN

**MODERATOR** : K SEDUMEDI

**NUMBER OF PAGES** : 4 PAGES


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**INSTRUCTIONS** : ANSWER ALL QUESTIONS

**REQUIREMENTS** : CALCULATOR, RULER

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**QUESTION 1 (7 marks)**

Please draw a diagram and use percentage to explain how the chromite resources/reserves are used in world market.

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**QUESTION 2 (13 marks)**

A diagram of O-C-Fe-Cr is used to help understand the smelting process of charge chrome, produced in a submerged arc furnace. Please draw the diagram with all names of the products.

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**QUESTION 3 (10 marks)**

Electrode breakage is one of the main challenges facing the production of charge chrome in submerged arc furnace in South Africa. Describe different types of breakages with main causes.

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**QUESTION 4 (20 marks)**

Premus is one of the production processes used to produce charge chrome in South Africa. Please use I-P-O process model to answer the following questions of the process:

1. Give the details of 5 raw materials used as inputs
  2. Give the details of 3 main outputs
  3. Draw the process flow-sheet
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**QUESTION 5 (50 marks)**

(1) Using charge recipe calculation with the attached conditions, please answer the following questions:

1. SiO<sub>2</sub> wt-% in SiO<sub>2</sub>-MgO-Al<sub>2</sub>O<sub>3</sub> slag?
2. How many kg of quartz?
3. How many kg of coke?

(2) Using the 5-zone model of Dr Pan with the attached conditions, please calculate the mass balance in each zone

The required conditions are as the followings:

- 12570 kg of ore
- Final alloy with 3-5% Si, and 6-8% C
- Final slag with 12-14%Cr<sub>2</sub>O<sub>3</sub>, and 6-8%FeO
- The chemical compositions of raw materials are given in Table 1. The required liquidus temperature is 1500 °C for the slag of SiO<sub>2</sub>-MgO-Al<sub>2</sub>O<sub>3</sub>.
- The atomic weights of some elements are listed in Table 2, and the SiO<sub>2</sub>-MgO-Al<sub>2</sub>O<sub>3</sub> phase diagram is given in Figure 1.

Please submit the Figure 1 together with your answer sheet/s.

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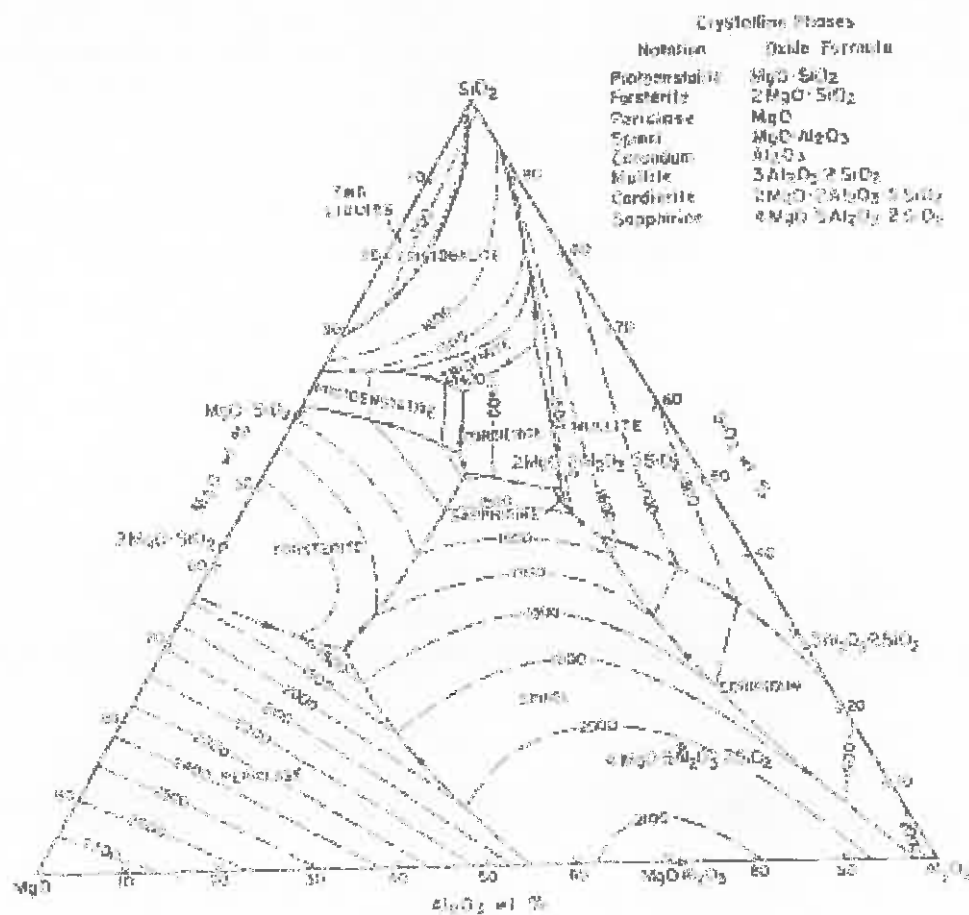
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Table 1. Raw Material Composition

| Name   | Cr <sub>2</sub> O <sub>3</sub> % | FeO% | Fe <sub>2</sub> O <sub>3</sub> % | MgO% | SiO <sub>2</sub> % | Al <sub>2</sub> O <sub>3</sub> % | H <sub>2</sub> O% | C% |
|--------|----------------------------------|------|----------------------------------|------|--------------------|----------------------------------|-------------------|----|
| Ore    | 39                               | 23   | 0                                | 10   | 9                  | 14                               | 5                 | 0  |
| Quartz | 0                                | 0    |                                  | 0    | 100                | 0                                | 0                 | 0  |
| Coke   | 0                                | 0    |                                  | 0    | 7                  | 4                                | 0                 | 89 |

Table 2. Atomic Weight

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

Figure 1. SiO<sub>2</sub>-MgO-Al<sub>2</sub>O<sub>3</sub> Phase Diagram

Total = 100%

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