UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING METALLURGY*
SUBJECT	:	PRODUCTION OF IRON AND STEEL
CODE	:	PRS21-1
DATE	:	WINTER EXAMINATION 2016 14 JUNE 2016
DURATION	:	(SESSION 2) 12:30 - 15:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	100

EXAMINER	:	DR S BHERO
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NUMBER OF PAGES	:	4 PAGES

INSTRUCTIONS	:	ANSWER ALL QUESTIONS
REQUIREMENTS	:	CALCULATOR

QUESTION 1 (40 MARKS)

1.1 Briefly explain reasons for the following pertaining to the blast furnace.

(a) Particle size distribution of the burden has to be optimum. (2)

(b) Steam is sometimes injected into the furnace. (2)

(c) Sinter a better charge is better than lump ore. (2)

(d) The shape of the furnace stack is an inverted cone and the hearth has smaller diameter than the bosh. (2)

(e) The blast furnace is served by three stoves. (2)

1.2 Table 1 below shows the composition of blast furnace slag in percentage:

CaO	SiO_2	Al_2O_3	MgO	FeO/Fe_3O_4	P	S
46	35	11	8	1	0.04	1.5

(a) Why is sulphur much higher than phosphorus in slag? (2)

(b) Calculate the basicity of slag and comment on its suitability. (2)

(c) What does 1% FeO/Fe_3O_4 show and what is the effect on the quality of iron? (2)

(d) What would you do to improve blast furnace conditions with respect to (c)? (2)

(e) What are the main sources of alumina and sulphur? (2)

1.3 How are the following conditions of the blast furnace corrected?

(a) Slag and hot metal temperatures are too low. (2)

(b) Slag basicity is 0.8 and slag is viscous. (2)

(c) Top gas analysis is 16% CO, 15% CO_2, 3% H_2 and 10% H_2O. (2)

(d) Top gas temperature is 1000°C. (2)

(e) The furnace is driving too fast. (2)

1.4 Comment whether the metallurgist is correct or not on the following about blast furnace:

(a) Blending of ores is unnecessary since reduction will still occur in the furnace. (2)

(b) If the furnace is too hot, wet ore can be charged to cool the furnace. (2)

(c) Phosphorus content in iron can be lowered by control of blast furnace process. (2)

(d) Coke oven gas can be suitable as tuyere injection for the blast furnace. (2)

(e) Tuyere injections boost productivity of the blast furnace. (2)

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QUESTION 2 (40 MARKS)

2.1 What are the reasons for the following pertaining to the LD steel making process:

(a) Mixers are necessary for hot metal storage prior to LD blowing. (2)

(b) A desulphurising plant may not be necessary if blast furnace process is efficient. (2)

(c) High phosphorus iron may be tolerated in LD but not high sulphur. (2)

(d) High manganese iron may be tolerated in LD but not high silicon. (2)

(e) High coke iron may be tolerated in LD but not high blast furnace slag. (2)

2.2 With reference to the blowing process briefly explain why:

(a) Manganese and carbon are oxidized after silicon? (2)

(b) Lime is charged in the early stages of the blow? (2)

(c) The blow can sometimes be shortened to 15 minutes instead of 20? (2)

(d) Phosphorus is oxidized right at the end of the oxygen blow? (2)

(e) Carbon cannot be oxidised completely like silicon? (2)

2.3 With respect to end of blow i.e. "turn down", what action is taken if?

(a) Temperature is too low e.g. 1599°C. (2)

(b) Phosphorus is too high, e.g. 0.08%. (2)

(c) Sulphur is too high, e.g. 0.09%. (2)

(d) Parts of refractory lining are getting warn. (2)

(e) There has been severe slopping during the blow. (2)

2.4 A 60 ton LD vessel has turn down analysis of 0.05% C, 0.15% Mn. Given that coke is 88% C, ferromanganese contains 80% Mn and ferrosilicon contains 64% Si, and that the customer requires a steel grade with 0.45% C and 0.85% Mn and 0.2% Si, calculate:

(a) The amount of coke required. (2)

(b) The amount of ferromanganese required. (2)

(c) The amount of ferrosilicon required. (2)

(d) What may cause the amounts calculated in (a), (b) and (c) to be inadequate. (2)

(e) In view of your answer in (d), what steps will you take to always meet the grade? (2)

QUESTION 3 (20 MARKS)

3.1 Pertaining to iron making and steel making, explain why:

(a) Iron making is a reduction process while steel making is an oxidising process. (2)

(b) High FeO/Fe_2O_3 is desirable in LD slag but not in blast furnace slag. (2)

(c) Tapping temperatures are 1660°C for LD blown metal but 1450°C for hot metal. (2)

(d) LD top gases are high in O_2 while blast furnace top gases are high in N_2. (2)

(e) Refractories for the LD basic, but neutral for the BF hearth? (2)

3.2 In comparison between blast furnace (BF) and LD steel making processes:

(a) Write balanced equations for the main reactions providing heat for processes. (2)

(b) BF and LD processes complement to control S and P in steel, why? (2)

(c) BF and LD batch are processes, why is tap-to-tap time longer at 8 hours for BF? (2)

(d) How does mineral dressing save on fluxes in BF? (2)

(e) Why are the Boudouard and "carbon boil" the main reactions for the BF and LD. (2)

Total = 100
