UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA **ENGINEERING METALLURGY**
SUBJECT	:	**PRODUCTION OF IRON AND STEEL**
CODE	:	**PRS21-1**
DATE	:	JULY SSA EXAMINATION 2014 JULY 2014
DURATION	:	(SESSION 2) 11:300 - 14:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	100

EXAMINER	:	DR S BHERO
MODERATOR	:	DR N NAUDE
NUMBER OF PAGES	:	3 PAGES

5063

INSTRUCTIONS	:	ANSWER ALL QUESTIONS
REQUIREMENTS	:	CALCULATOR

QUESTION 1 (20 marks)

1.1 Explain how the following reduce coke rate:

1.1.1 Tuyere injections (2)

1.1.2 Increased sinter charge (2)

1.1.3 High blast temperature (2)

1.1.4 Mineral dressing (2)

1.1.5 Oxygen enrichment of the blast (2)

1.2 Make some sketches and explain how

1.2.1 Too wide particle size distribution results in poor reduction of charge. (2)

1.2.2 Too narrow particle size distribution results in poor reduction of charge. (2)

1.2.3 Too large mono-size particles result in poor reduction of charge. (2)

1.2.4 Too fine charge particles result in poor reduction of charge. (2)

1.3 The refractories used in the blast furnace are either acidic or neutral.

1.3.1 Explain reasons for the refractories used in different parts of the furnace. (2)

1.3.2 Why are acidic refractories not attacked by fluxes in the blast furnace? (2)

QUESTION 2 (20 marks)

2.1 What does the following indicate about the condition of the blast furnace:

2.1.1 Top gas analysis shows CO: CO_2 = 1:1, H_2: H_2O = 1:2. (2)

2.1.2 Slag basicity of 0.8. (2)

2.1.3 Iron analysis of low silicon and high sulphur. (2)

2.1.4 Slag of low viscosity, low [S] and high [Si]. (2)

2.1.5 Top gas temperature is 600°C, CO:CO_2= 3:1, H_2: H_2O =3:1. (2)

2.2 A lump of magnetite charged is reduced in the blast furnace

2.2.1 Make a sketch of the lump leaving the upper zone if reduction was incomplete. (2)

2.2.2 Make a sketch of the lump leaving the upper zone if reduction was effective. (2)

2.2.3 Make a sketch of the lump from 2.2.2 at the bottom of the middle zone if the reaction was almost complete. (2)

2.2.4 Make a sketch of the lump at the bottom of the middle zone if the reaction was effective. (2)

2.3 Hot metal Mn comes from the equation: MnO + C = [Mn] + CO.

2.3.1 Determine the thermal range for the reaction. (2)

3/...

QUESTION 3 (20 marks)

3.1 Explain why the following are necessary for steelmaking

3.1.1 Carry-over of slag from the blast furnace must be kept to a minimum. (2)

3.1.2 Hot metal silicon content should be known prior to LD charging. (2)

3.1.3 Desulphurisation of hot metal may be carried out prior to LD. (2)

3.1.4 The LD refractories are basic graphite impregnated MgO (2)

3.1.5 Lime is added at the beginning of the blow while mill-scale is added at the end. (2)

3.2 Some procedures can be followed to reduce process costs of steel making.

3.2.1 Explain the 'carbon catch' procedure and how it improves economies of the LD. (3)

3.2.2 What conditions govern the decision to follow the 'carbon catch' procedure? (3)

3.2.3 Explain the effects of poor quality lime on the economies of the LD process. (2)

3.2.4 Briefly explain any three causes of low reactivity of lime. (2)

QUESTION 4 (20 marks)

LD Slag wt%	**CaO**	**SiO_2**	**MgO**	**Al_2O_3**	**MnO**	**Fe_2O_3**	**FeO**	**Fe**	**S**	**P**
Vanderbijlpark	36	12	10	4	4.8	15.3	12.1	3.9	0.25	2
New Castle	35	36	10	13					0.2	0.5

Using the data in the Table above, answer the questions below:

4.1 Where in the plant would you use of the LD slag and for what benefit? (4)

4.2 Explain the possible reasons for the following:

4.2.1 Blast furnace slag has much more Al_2O_3 than BOF slag. (2)

4.2.2 Phosphorus is higher in Vanderbijlpark slag than New Castle slag. (2)

4.2.3 LD slag at New Castle contains more silica than at Vanderbijlpark (2)

4.2.4 Vanderbijlpark slag contains Fe_2O_3 and FeO while New Castle does not. (2)

4.3 Calculate the basicity ratios of slag at Vanderbijlpark and of New Castle. (2)

4.4 Comment on the following:

4.4.1 The effect slag at New Castle and Vanderbijlpark on the LD. (2)

4.4.2 The refractory lining you would recommend for the two plants. (2)

4.4.3 Vanderbijlpark slag contains 3.9% iron while New Castle slag does not. (2)

[20]

Total = 100

Thermodynamic Data

$C + ½O_2 = CO_{(g)}$	$\Delta G^o = -111700 - 88T$
$C + O_2 = CO_{2(g)}$	$\Delta G^o = -394100 - 0.8T$
$Mn + ½O_2 = MnO$	$\Delta G^o = -403000 + 90T$