

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING (HONS) DEGREE
Part Five Examination May 2011

TCE5007 Advanced Minerals Engineering

Duration of Examination 3Hours

Instructions to Candidates

1. Answer any **FOUR** questions.
2. Show all your steps clearly in your calculation.
3. Start the answers for each question on a new page.

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1. a) What are the organic components of coal? [5]
 - b) Coke is an important raw material in the pyrometallurgical industry.
 - (i) Give a brief description of the coal carbonization process. [8]
 - (ii) What are the uses of coke in the pyrometallurgical industry? [2]
 - c) Use the given float and sink data to determine the expected yield of coal and the required density of separation for the following product ash content.
 - (i) 3% ash content [3]
 - (ii) 5% ash content [3]
 - (iii) 7.5% ash content [4]

Specific gravity (s.g)	Weight (%)	Ash content (%)
< 1.3	49.4	1.7
1.3-1.4	20.6	5.3
1.4-1.5	6.3	15.6
1.5-1.6	4.0	26.8
1.6-1.8	2.9	39.5
1.8-2.0	2.2	59.8
2.0-2.2	2.5	71.3
>2.2	12.1	79.3

2. a) Explain the role of each raw material used in the blast furnace for iron ore reduction. [8]
- b) State five essential characteristics of iron ore charged into the blast furnace and explain the effect of each on the reduction process. [15]
- c) What is the purpose of sintering in the iron making process? [2]
3. a) Explain the temperature profile in the blast furnace. [8]
- b) The steel making industry employs a number of production methods, select one method and give a full description (including reactions and operating conditions) of the steel making process using this method. [10]
- c) Steel is iron with a carbon content less than 2%; different alloying elements are added to give a wide range of steels with specific properties. State five alloying elements, what special properties does each element add to steel? [7]
4. a) Describe how you would separate sphalerite (ZnS) from an ore containing galena (PbS). [5]
- b) A fluidised bed roaster, designed to treat 1000 tons/day of concentrates is currently working at 7.5 % below capacity, and is used to roast wet concentrates with the following composition;

Component	Composition (%)
ZnS	58%
PbS	24%
Cu ₂ S	11%

Ambient air is used during fluidisation, the calcine which is discharged at 1400 K has the following components;

Composition of calcine : ZnS, ZnO, PbO, Cu₂O

The analysis of the flue gases show that the gases are made up of 15 % SO₂ which accounts for 97 % of the sulphur originally contained in the concentrates.

- (i) What is the composition of the wet feed? [2]
(ii) What is the composition of the calcine? [3]
- c) Roasting of ZnS ore i.e. ($ZnS + 1.5O_2 = ZnO + SO_2$) can be achieved by sintering the fine ore particles using a Dwight-Lloyd machine. State 5 conditions which are essential for down-draught sintering of ZnS ore and explain their effect on the process. [10]
- d) What is galvanising? [5]
5. a) Compare and contrast eletrowinning and electrorefining. [5]
- b) What are the leaching process variables and what is their effect on the leaching process? [8]
- c) Draw and label a sketch of an Outokumpu Flash Smelting Furnace. [3]
- d) Give a short explanation of the chemical and physical changes that occur to the charge in the Outokumpu Flash Smelting furnace. [3]
- e) Discuss advantages and disadvantages of the Flash Smelting process in comparison to a reverberatory furnace. [6]

END OF EXAM