



**NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY**
FACULTY OF ENGINEERING AND SPATIAL SCIENCES

DEPARTMENT OF MINING AND PROCESS ENGINEERING

QUALIFICATION : BACHELOR OF ENGINEERING IN METALLURGY	
QUALIFICATION CODE: 08BEMT	LEVEL: 7
COURSE CODE: HMT 710S	COURSE NAME: HYDROMETALLURGY 314
SESSION: JUNE 2022	PAPER: THEORY
DURATION: 2 HOURS	MARKS: 60

FIRST OPPORTUNITY QUESTION PAPER	
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INSTRUCTIONS
<ol style="list-style-type: none">1. Answer all questions.2. Read all the questions carefully before answering.3. Marks for each question are indicated at the end of each question.4. Please ensure that your writing is legible, neat and presentable.

PERMISSIBLE MATERIALS

1. Examination paper.

THIS QUESTION PAPER CONSISTS OF 4 PAGES (Including this front page)

Question 1**[13]**

The typical way of operating a solvent extraction process is to run a continuous counter-current multi-stage system. In these operations, organic substances such as Kerosine are used.

- 1.1 Why does copper sulphate dissolve in water and kerosene does not? (2)
- 1.2 Where and how is this difference in 1.1 best utilised in hydrometallurgical processes? (3)
- 1.3 Instead of precipitation, it is proposed that solvent extraction can be used in the purification of the solution. If given the general formula of the extractant to be RH:
 - a) Write down the reaction that represents the loading of copper on the solvent. (1)
 - b) Explain the importance of pH in the solvent extraction process. (2)
- 1.4 The concept of solvent extraction has become an integral part of copper recovery. Briefly explain why solvent extraction as a way of purifying solution has an advantage over precipitation in this process. (5)

Question 2**[15]**

- 2.1 In a traditional Roast – Leach – Electrowin (RLE) process, iron is the main impurity. Goethite process is one way of removing iron from leach solution. The process is conducted at elevated temperatures and in solutions with fairly dilute concentrations of iron.
 - a) Why would you say goethite process is better compared to jarosite and hematite processes? (2)
 - b) Explain the importance of elevated temperatures and dilute solutions. (4)
 - c) Given that oxygen forms the supporting cathodic reaction, give your opinion on the effect of operating conditions on this process. (2)
- 2.2 You are given a process stream from the zinc sulphate leach system that contains 20g/l Fe that has to be precipitated as goethite and the solution flowrate is 1.5 m³ per hour. If 90% of iron is precipitated, calculate the mass of goethite produced per hour. Molar masses: Fe = 56; O = 16; H = 1. (7)

Question 3

[10]

Gold may be recovered from cyanide solutions by use of the zinc-cementation process.

- 3.1 Make use of the Eh-pH diagram below for drawing a suitable sketch to explain the electrochemical principles of the process. (5)
- 3.2 Explain what would happen should the concentration of cyanide ions increase and decrease respectively. (5)

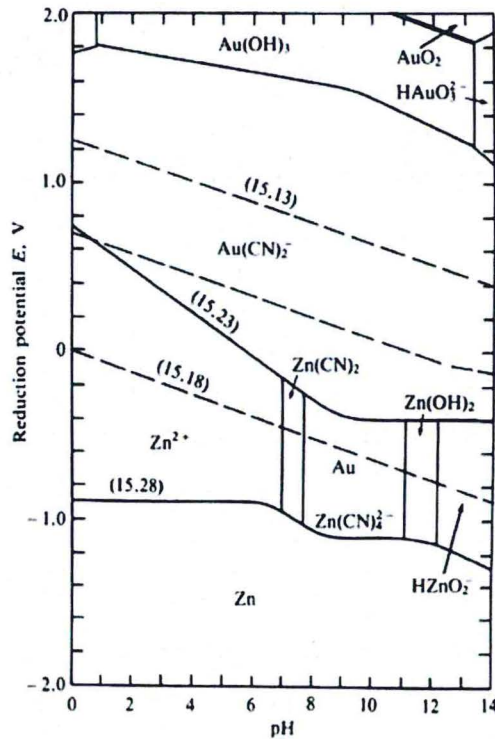


Figure 15.2. Potential-pH equilibrium diagram illustrating features of the Au-CN-H₂O and Zn-CN-H₂O systems at 25°C. $[\text{CN}^-]_{\text{total}} = 10^{-2} \text{ mol l}^{-1}$, $[\text{Au}(\text{CN})_2^-] = 10^{-4} \text{ mol l}^{-1}$, $[\text{Zn}^{2+}]_{\text{total}} = 10^{-2} \text{ mol l}^{-1}$.

Question 4

[22]

The following steady – state data was obtained from a gold plant using the carbon – in – pulp process which treats 1000t/d of an ore with a head grade of 4.01 g/t as a slurry containing 45% solids at a pulp density of 1.40 t/m³. All the tanks are of the same nominal size. The generated carbon contains 150 g/t of gold.

Tank	Assay, g/t			Carbon	Carbon concentration g/l
	Solids	Solution	% Extraction		
Feed	4.01	0.05			
1	1.48	2.18			
2	1.15	2.67			
3	0.99	3.09			
4	0.88	3.25			
5	0.79	2.05		5352	9.5
6	0.69	1.56		3132	4.8
7	0.58	0.91		1644	8.6
8	0.45	0.51		870	6.5
9	0.36	0.28		526	7.4
10	0.27	0.09		348	12.5

- 4.1 Estimate the flow – rate of carbon that is consistent with the data. (9)
- 4.2 Calculate the % of gold extracted by the carbon from the solution in each stage and comment on the relative values obtained. (6)
- 4.3 Give two possible reasons for the relatively high gold concentration in the solution tails and suggest how this problem could be solved. (2)
- 4.4 Discuss some advantages and disadvantages of converting Tank 4 into a CIL rather than just a leach tank. (5)

