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#### MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

**FACULTY OF ENGINEERING, APPLIED SCIENCES AND TECHNOLOGY**

**DEPARTMENT: MINING AND MINERAL PROCESSING ENGINEERING**

**MODULE: HYDROMETALLURGY 2**

**CODE: ENGM 315**

**SESSIONAL EXAMINATIONS**

**JUNE 2023**

**DURATION: 3 HOURS**

**EXAMINER: Miss F.E. CHARANGWA**

## INSTRUCTIONS

1. *Answer any five (5) questions*
2. *Start a new question on a fresh page*
3. *Total attainable marks 100*

***Additional material(s):*** *Calculator*

**Question 1**

1. Commercial lithium extraction technology or methods currently depend on two main sources of the metal; from its salts and mineral ores, such as spodumene. Give a detailed processing flowsheet from the run of mine of the ore. **(15Marks)**
2. Name the challenges faced with lithium production. **(5Marks)**

**Question 2**

1. Explain the following terms:
2. Common ion effect. **(2Marks)**
3. Buffer solutions. **(2Marks)**
4. Modifier in relation to solvent extraction. **(3Marks)**
5. Difference between the following terms:
6. Electro-refining and electro-winning**. (2Marks)**
7. Carbon in pulp and Carbon in leach. **(2Marks**)
8. Hydrolysis and hydration. (**2Marks**)
9. Raffinate and filtrate. **(2Marks)**
10. State and explain the 5 stages involved in the dissolution of metals. **(5Marks)**

**Question 3**

1. Explain any five characteristics of heterogeneous reactions in hydrometallurgy**. (10Marks)**
2. Outline concisely justifying the steps you would take in making appropriate decisions in the design of a hydrometallurgical reactor.  **(10Marks)**

**Question 4**

1. What do you understand by refractory gold ore? **(4Marks)**
2. Suggest ways of recovering gold from a refractory ore, and explain them briefly**. (8Marks)**
3. Solution purification and enrichment is necessary after leaching but before recovering of the mineral of interest. Solvent extraction or ion exchanging can be used for purification. Describe any one of the methods used in hydrometallurgy giving examples. **(8Marks)**

**Question 5**

1. Copper is electrolytically refined at 60$℃$ using an electrolyte containing 42 g/liter of copper. The voltage drop from the anode to cathode is 0.03V. At what silver ion concentration in the electrolyte could silver be plated out at the cathode?

 **Given:** The half-cell reactions:

Ag(s) = $Ag^{+}$ + e-, E˚ = -0.7990V

Cu(s) = $Cu^{+}$+ e- , E˚ = - 0.3411V

Atomic weights for silver and copper are 107.86 and 63.54 respectively

R is the universal gas constant = 8.314462 J/(mol.K) **(10Marks)**

1. Describe, with two examples, the cementation process**. (10Marks)**

**Question 6**

1. Covellite may be leached using Fe(III) salts, as shown below:

 $Cu^{2+}$+ S + 2$e^{-}$ = CuS E= 0.59v

 $2Fe^{3+}$+ 2$e^{-}$ = $2Fe^{2+} $E= 0.77v

1. Write down the overall reaction **(2Marks)**
2. Calculate the standard free energy change of the reaction **(2Marks)**
3. Write down the Nernst equation for the above reaction and show how the potential of the reaction can be increased **(2Marks**)
4. Name the 4 factors that influence the choice of a lixiviant. **(4Marks)**
5. The recovery of gold is somehow the most important and abundantly widely processed mineral in Southern Africa. You have been hired by one of the big companies in the region and have been tasked to layout some of the factors that are leading to low gold recoveries in their hydrometallurgical leach plant. As a metallurgist write short notes, which you would present to the general manager, on the factors that are hindering the full efficiency of the leach plant**. (10Marks)**

**Question 7**

1. With the aid of relevant chemical equations, describe the role of cyanide and mercury in gold extraction. **(8Marks)**
2. Use the micro-structure of an activated carbon flake to explain the mechanisms involved in the uptake of gold from its cyanide solution. A schematic drawing of the micro-structure would assist in the explanation.  **(6Marks)**
3. Activated carbon is used in the extraction of gold. Progressively carbon loses its activity. The continuing activity of the carbon is very dependent upon its regeneration process. Explain the thermal regeneration of carbon for gold extraction. **(6Marks)**

**\*\*\*\*THE END\*\*\*\***