STRATHMORE UNIVERSITY
SCHOOL OF COMPUTING AND ENGINEERING SCIENCES
Bachelor of Electrical Engineering
Final Examination
CHE1201: CHEMISTRY II

DATE: 8th November 2021 **TIME: 2 hours**

Instruction: Answer question one and any two other questions.

Question One

Electrochemistry Processes

I Replacement and Oxidation **[10 marks]**

In electrochemistry processes, chemical reactions can be used to produce electrical energy and electrical energy can be used to produce chemical energy.

a) In an experiment aluminum rod is dipped in a beaker containing aqueous copper chloride and left for one hour what are the observations? (2 marks)

b) Write down all the chemical equations for the reactions (3 marks)

c) If copper rods were dipped in aqueous solution in a beaker containing $AlCl_{3(aq)}$. What would be the observations? (2 marks)

d) Give the reasons for your observations (3 marks)

II Batteries **[20 marks]**

a) In the experiment below, the bulb is observed to light when the circuit is complete, explain the observation made. (3 marks)

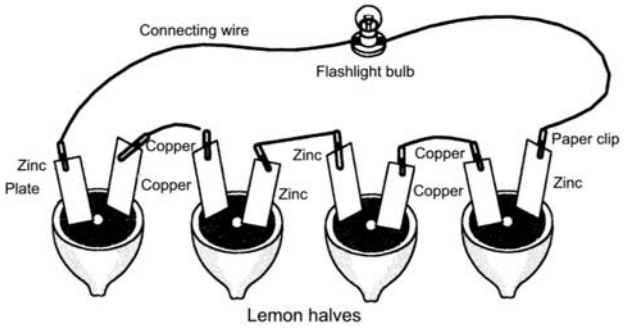


Figure : Circuit diagram of lemon battery

b) Determine if the cell reaction below will proceed spontaneously (3 marks)
$E^o_{Hg2+} = 0.854V$, $E^o_{Ag+} = 0.800V$

$$Ag(s) \mid Ag^{+}(0.075M) \parallel Hg^{2+}(0.85M) \mid Hg(l)$$

c) What will be the concentrations of Ag^+ and Hg^+ in the cell above when the cell is discharged completely at 25ºC. (3 marks)

d) Why is the anode positive (+) in an electrolytic cell but negative (-) in a voltaic cell. (4 marks)

e) An electrodeposition of copper can be used to determine content of a sample. The sample is dissolved to produce $Cu^{2+}_{(aq)}$, which is electrolyzed. At the cathode, the reduction half-reaction is

$$Cu^{2+}(aq) + 2e^{-} \rightarrow Cu$$

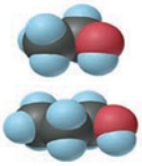
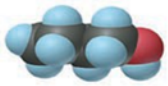
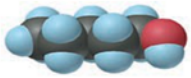
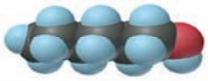
What mass of copper can be deposited in 1 hour by current of 1.62 A? (3 marks)

g) The alkaline leclanche dry cell is considered superior to the acidic leclanche dry cell. Explain. (2 marks)

h) What is the relationship of the size of electrodes and the volume of electrolyte to the total amount of current drawn from a cell? (2 marks)

Question Two (Inter- molecular Forces and Solubility)

a) The table below gives a comparison of solubility values of different alcohols in water and hexane.

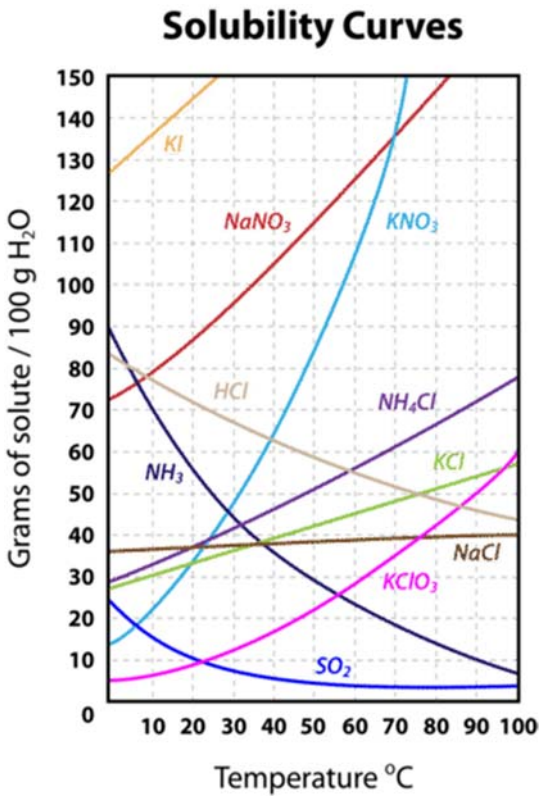
Alcohol	Model	Solubility in Water	Solubility in Hexane
CH_3OH (methanol)		∞	1.2
CH_3CH_2OH (ethanol)		∞	∞
$CH_3(CH_2)_2OH$ (1-propanol)		∞	∞
$CH_3(CH_2)_3OH$ (1-butanol)		1.1	∞
$CH_3(CH_2)_4OH$ (1-pentanol)		0.30	∝
$CH_3(CH_2)_5OH$ (1-hexanol)		0.058	∝

*Expressed in mol alcohol/1000 g solvent at 20°C.

i) Explain the trend of solubility of alcohols in water (3 marks)
ii) Explain the trend of solubility of alcohols in hexane (3 marks)

b) Water is called the "universal solvent". Explain using diagrams why this is the case (3 marks)

c) The diagrams show solubility curves of various substances in water as a function of temperature. Explain the trend of solubility for each species (6 marks)



Question Three (Acids and Bases)

a) Buffer solutions are used in industrial processes to control pH in chemical reactions

i) Show that an NH_3-NH_4Cl solution is a buffer solution (3 marks)

b) An experiment is done to prepare a buffer solution, to obtain a pH of 9.00 a 36mL of 0.200M NH_3 is mixed with 64mL of 0.200M NH_4Cl.

$K_a = 5.56 \times 10^{-10}$

i) Show by calculation that the pH of this solution is 9.00 (4 marks)

ii) Would you expect the pH of this solution to remain at 9.00 if 100mL of buffer solution were diluted to 1 litre? (4 marks)

iii) What will be the pH of the original 100mL of buffer solution if 0.20mL of 1.00M HCl is added to it? (4 marks)

Question Four (Organic Chemistry and Reactions)

a) Write the structural formulas for the organic compounds:

i) Heptane (1 mark)

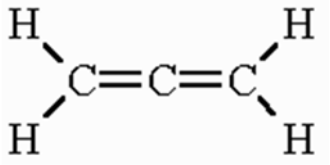
ii) Propanoic acid (1 mark)

iii) 2-methyl-1-pentanol (1 mark)

iv) Fluoroethane (1 mark)

v) Ethene (1 mark)

b) The structure of the molecule allene, CH_2CCH_2 is shown here. Propose hybridization schemes for the C atoms in this molecule. (4 marks)



c) When $(CH_3CH_2)_3CBr$ is added to CH_3OH at room temperature, the major product is $CH_3O(CH_2CH_3)_3$ and minor product is $CH_3CH=C(CH_2CH_3)_2$.

Write out the mechanisms for the reactions leading to these products. (6 marks)

Question Five (Analysis in Electrochemistry)

In an experiment a sensor is calibrated by measuring the steady-state current when it is immersed in standard solutions of glucose. A typical set of calibration data is shown in the following table.

Miligrams of glucose/100 mL (arb. units)	Current (Milliamperes)
2	17.2
4	39.2
6	52.1
8	68
10	85.8

A 2.00-mL sample of a solution containing an unknown amount of glucose is diluted to 10 mL in a volumetric flask, and a steady-state current of 23.6 is measured.

i) Plot the graph of the relation (5 marks)

ii) What is the concentration of glucose in the sample in milligrams per 100 mL? (10 marks)