



UNIVERSITY OF GHANA
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BSC. ENGINEERING

SECOND SEMESTER EXAMINATIONS: 2016/ 2017

DEPARTMENT OF BIOMEDICAL ENGINEERING

BMEN 304: SOLUTION AND COLLOID CHEMISTRY (3 CREDITS)

INSTRUCTIONS:

ANSWER **THREE (3)** QUESTIONS IN ALL. ANSWER **QUESTION ONE** AND ANY OTHER TWO QUESTIONS

TIME ALLOWED: THREE (3) HOURS

Question 1 [40 Marks]

- In dilution, the concentration of the solution decreases but the amount of substance remains the same. Explain [5 Marks]
- State five differences between a galvanic cell and an electrolytic cell. [5 Marks]
- A solution containing both HF and NaF becomes less acidic than the one that contains only the weak acid (HA). Explain. [5 Marks]
- The vapour pressure of a solution is lower than that of the pure solvent. Explain. [5 Marks]
- A reagent bottle was found to contain acetic acid with the following inscription on the bottle: CH_3COOH (98%); density (1.0 g/cm^3). You are required to prepare a 100 cm^3 of 6.0 M CH_3COOH solution. Describe how you will prepare this solution. (C =12, O = 16, H =1) [20 Marks]

Question 2 [30 Marks]

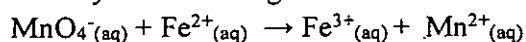
- a. i. State Raoult's Law. [2 Marks]
ii. Using intermolecular forces explain what gives rise to positive deviation and negative deviation from Raoult's law? [4 Marks]
iii. If a solution shows a positive deviation from Raoult's law, would you expect it to have a higher or lower boiling point than if it was ideal? Why? [4 Marks]
- b. A solution was prepared by adding 20.0 g of urea to 125 g of water at 25 °C, a temperature at which pure water has a vapour pressure of 23.76 torr. The observed vapour pressure of the solution was found to be 22.67 torr. Calculate the molar mass of the urea. [mm of water = 18 g/mol]. [10 Marks]
- c. A piece of jewellery is to be gold plated by electrolysis using $\text{Au}(\text{NO}_3)_3$. If a current of 0.40 A is passed through the solution for 30.6 minutes, calculate the mass of gold deposited on the jewellery. [Au = 197, F = 96,500 C] [10 Marks]

Question 3 [30 Marks]

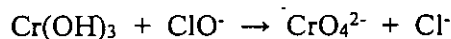
- a. Differentiate between the strength of a base and concentration of a base. [4 Marks]
- b. Explain why aqueous solutions of NH_3 and CH_3COOH are weak electrolytes but a mixture of the two forms a strong electrolyte. [6 Marks]
- c. Oxochlorate (I) acid (HClO) is a weak acid with $K_a = 3.2 \times 10^{-8}$ M. Calculate:
i. $[\text{H}_3\text{O}^+]$
ii. $[\text{OH}^-]$
in 1.25×10^{-2} M oxochlorate acid solution. ($K_w = 1.0 \times 10^{-14} \text{ mol}^2/\text{dm}^2$). [8 Marks]
- d. The reaction $\text{CO}_{(\text{g})} + 2\text{H}_{2(\text{g})} \rightleftharpoons \text{CH}_3\text{OH}_{(\text{g})}$ $\Delta H = -92 \text{ KJ}$ is thermodynamically feasible at a certain temperature. State and explain what happens to the concentrations of H_2 , CO and CH_3OH which are in equilibrium according to the equation when
i. Volume of the containing vessel is reduced. [4 Marks]
ii. Temperature is increased. [4 Marks]
iii. Catalyst is added. [4 Marks]

Question 4 [30 Marks]

- a. Explain why the following reaction is a **REDOX** reaction [2 marks]



- b. The following reaction occurs in an alkali medium



- List the species that is reduced and the one that is oxidized. [4 Marks]
 - State the initial and final oxidation numbers of the species you have listed. [2 Marks]
 - Separate the reaction into two half-reactions and balance each of them. [6 Marks]
 - Write the overall balanced equation. [2 Marks]
- c. One mole of CH_3COOH is mixed with one mole of $\text{CH}_3\text{CH}_2\text{OH}$ in a closed vessel at 298K. The reaction mixture at equilibrium was found to contain 0.66 moles each of H_2O and $\text{CH}_3\text{COOCH}_2\text{CH}_3$. Assume the volume of the vessel is 1 dm^3 .
- Write the equation of the reaction [4 Marks]
 - Calculate K_c [8 Marks]
 - State the units of K_c [2 Marks]

Question 5 [30 Marks]

- a.
- State Beer-Lambert's Law [2 Marks]
 - If a solution of X^{2+} has an absorbance of 0.660, and the molar absorptivity of X^{2+} is $2.31 \times 10^5 \text{ A/M/cm}$ and the length of the light path is 2.2 cm, what is the concentration of X^{2+} in the solution? [4 Marks]
- b.
- Draw a labeled diagram of a galvanic cell which operates on the reaction
$$\text{Fe}^{2+} + \text{H}^+ + \text{Cr}_2\text{O}_7^{2-} \rightarrow \text{Fe}^{3+} + \text{Cr}^{3+} + \text{H}_2\text{O}$$

Show clearly the two electrode systems which make up the cell. [8 Marks]
 - Write a balanced equation for the half cell reactions and indicate the direction of flow of electrons. [8 Marks]
- c.
- Describe the electrolysis of copper(II)tetraoxosulphate(VI) solution (CuSO_4) using carbon electrodes. [4 Marks]
 - Will the copper(II)tetraoxosulphate(VI) solution be acidic or basic at the end of the electrolysis described in question (c) (i) above? Give reasons for your answer. [4 Marks]

2. a) State the three main components of the total pull force that a tillage implement exerts on a tractor. (6 marks)
- b) For each force component given, state how you would reduce the total effect of that force. (12 marks)
3. a) State three atmospheric conditions that affect the power generation of an Internal Combustion Engine. (3 marks)
- b) For each condition given, explain the specific effect it will have on the power generation of the Internal Combustion Engine. (9 marks)
4. a) To reduce the quantity of palm fruit that gets bruised during harvesting, you have been contracted to develop a palm fruit bunch harvesting mechanism. State two properties of the palm fruit bunch and explain how each property will influence your design. (10 marks)
- b) Describe how you will determine the accurate fan speed to use when you are designing a grain cleaning system. (5 marks)

AREN 301: Soil and Crop Mechanics Application to Mechanization (2016/2017)

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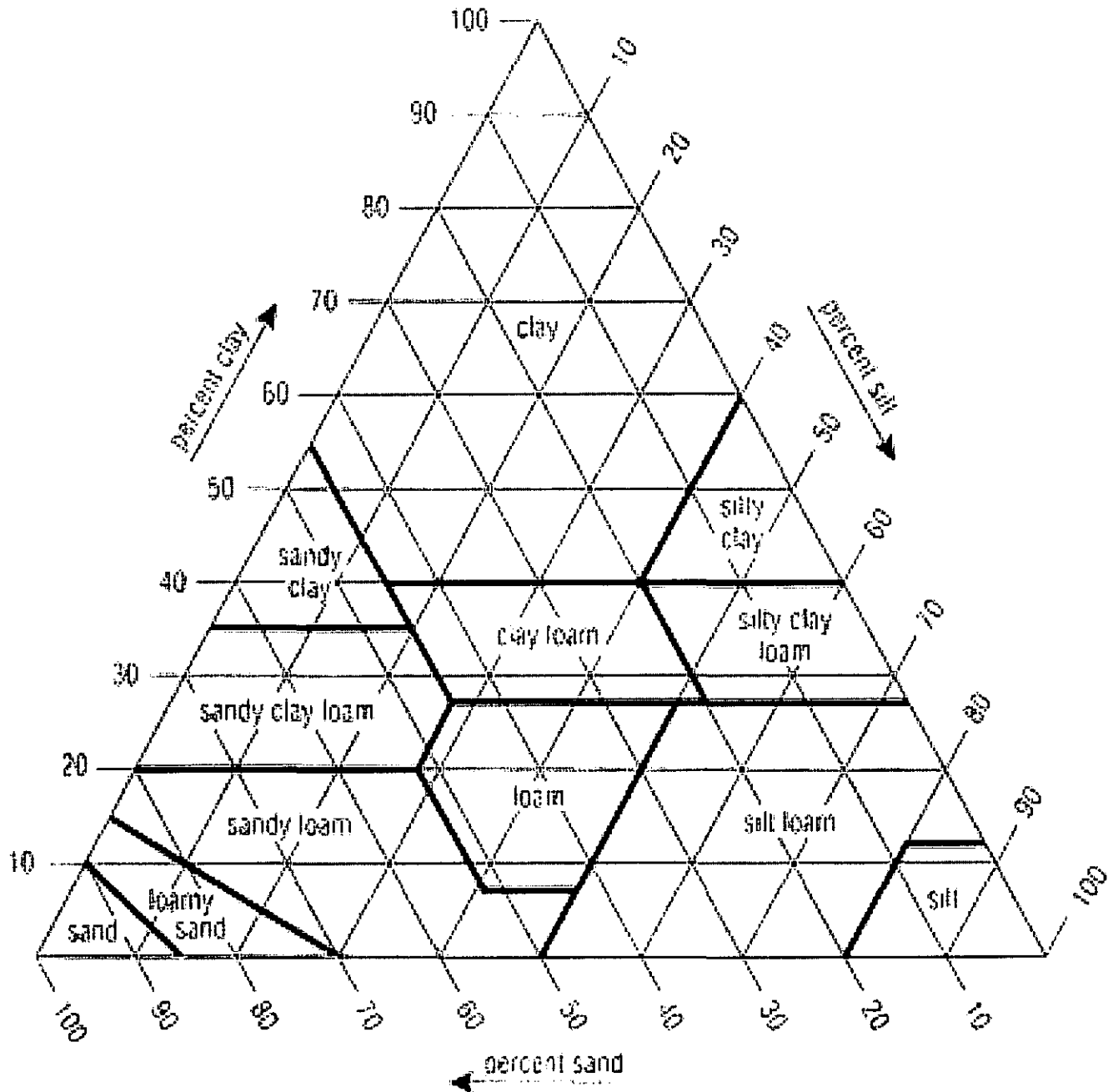


Figure 1. Chart for question one. (Detach this page and add to the answer booklet)