TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE & APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MEDICAL ENGINEERING

BACHELOR OF TECHNOLOGY IN MEDICAL ENGINEERING

ACH 4150 : CHEMISTRY FOR ENGINEERS

END OF SEMESTER EXAMINATION

SERIES: DECEMBER 2016

TIME: 2 HOURS

DATE: Pick Date Dec 2016

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Answer question ONE (Compulsory) and any other TWO questions.

Do not write on the question paper.

Question ONE

(a) Briefly describe the Lyman series of the emission spectrum of hydrogen, indicating the region of the electromagnetic spectrum the series occupies. (3 marks)

(b) State the four quantum numbers used to characterise an electron in an orbital, indicating the possible values of each. (4 marks)

(c) Define the following terms for a chemical reaction and indicate their relationship.
i. Activation energy ii. A catalyst (3 marks)

(d) Explain how a common ion affects the solubility of AgCl in $AgNO_3$. (6 marks)

(e) Briefly describe with suitable examples the following terms,
i. An amphiprotic solvent,
ii. A zwitterion. (6 marks)

(f) i. Write reaction equations showing the hydrolysis of $NaNO_2$ (2 marks)

ii. State whether $NaNO_2$ is an acidic, neutral or basic salt. (1 mark)

(g) Acid rain has a pH of 2.4. Calculate the H^+ ion concentration of the rainwater. (2 marks)

(h) Calculate the de Broglie wavelength for a neutron moving at 2.5×10^4 ms^{-1}.
(Mass of a neutron = 1.675×10^{-27} kg, and $h = 6.626 \times 10^{-34}$ J s) (3 marks

Question TWO

(a) Define the following terms,

i. Hund's rule (1 mark)

ii. Aufbau principle. (1 mark)

(b) Provide possible values of the quantum numbers that uniquely describe electrons in the following orbitals,

i. 3s

ii. 4p (4 marks)

(c) Ionisation energy usually increases from left to right across a given period. However, Al (Z = 13) has a lower 1st Ionisation energy than Mg (Z = 12). Provide an explanation on this observation.
(4 marks)

(d) Calculate the pH of a solution of 0.25 M NaCN solution, given the value of $K_a = 6.2 \times 10^{-10}$.
(10 marks)

Question THREE

(a) Explain the effect of the addition of a small amount of an acid or a base on a CH_3COONa/ CH_3COOH buffer solution. (6 marks)

(b) Calculate the pH of a 0.40 M CH_3COONa/ 0.50 CH_3COOH buffer system, given $K_a = 1.7 \times 10^{-5}$ at 25 °C. (6 marks)

(c) Describe the process of softening of hard water by ion exchange, indicating how the ion exchange resin is recharged. (4 marks)

(d) Identify the conjugate acid-base pairs for the following equations,

i. $2H_3O^+ + S^{2-} \rightarrow H_2O + H_2S$ (2 marks)

ii. $CO_3^{2-} + H_2O \rightarrow HCO_3^- + OH^-$ (2 marks)

Question FOUR

(a) Define the following terms,

i. Moles

ii. Molarity. (2 marks)

(b) A 24.8 ml solution of H_2SO_4 neutralizes 6.50 g of NaOH

i. Write down the balanced equation for the above reaction (2 marks)

ii. Calculate the molarity of the H_2SO_4 solution. (6 marks)
(H = 1, C = 12, O = 16, Na =23, S = 32)

(c) Describe the processes of nitrification and de-nitrification in the nitrogen cycle. (8 marks)

(d) Draw Lewis diagrams for the following molecules,

i. O_3 ii. CO_2 (2 marks)

Question FIVE

(a) For the redox reaction

$ClO_3^- + Cl^- \rightarrow ClO_2 + Cl_2$

i. Write the oxidation and reduction half reactions (2 marks)

ii. Balance the reaction in basic medium, showing all the steps in balancing. (10 marks)

(b) Given the K_{sp} for Aluminium hydroxide is 3.0×10^{-34} at 25 °C, calculate the following.

i. Molar solubility of Aluminium hydroxide and constituent ions (6 marks)

ii. Solubility in grams per litre for zinc hydroxide. (2 marks)
(H = 1, O = 16, Al = 27).