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) Assign oxidation numbers to the underlined elements in the following compounds and ion;

(i) $H_3\underline{P}O_4$ (ii) $Na\underline{B}H_4$ (iii) $\underline{Pt}Cl_6^{2-}$ (3 marks)

(b) Give any THREE assumptions of Bohr's theory of the structure of the H atom. (3 marks)

(c) 34.5 ml of a $KHCO_3$ solution neutralises 25 ml of a 0.25M HCl solution.

(i) Write a balanced equation of the neutralisation reaction (1 mark)

(ii) Calculate the concentration of the $KHCO_3$ solution. (3 marks)

(d) For the reaction

$H_2O_2 + Fe^{2+} \longrightarrow Fe^{3+} + H_2O$

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

(ii) Balance the reaction in acidic medium, showing all steps in balancing. (7 marks)

(e) (i) Briefly describe the characteristics of an amphoteric oxide. (1 mark)

(ii) Using appropriate reaction equations, show why Al_2O_3 is an amphoteric oxide. (4 marks)

(f) For an electronic transition from the n = 5 to n = 3 energy levels in a hydrogen atom;

(i) Calculate the energy of the emitted photon (3 marks)

(ii) Calculate the wave number of the emitted photon (3 marks)

($R_H = 2.18 \times 10^{-18}$ J; C = 2.99×10^9 ms^{-1}; h = 6.63×10^{-34} Js).

Question TWO

(a) State the Pauli Exclusion principle. (1 mark)

(b) State Hunds rule. (1 mark)

(c) Provide unique quantum numbers for the valence electrons in the C (Z=6) atom. (4 marks)

(d) Write electron configurations for the following elements and ions,

(i) Be (Z=4) (ii) P^{-3} (Z=15) (iii) Cr^2 (Z=24) (iv) N (Z=7) (4 marks)

(e) Explain how water can be purified by ionic exchange. (8 marks)

(f) Provide TWO characteristics of the H atom as a Group I and Group II element of the Periodic table. (2 marks)

Question THREE

(a) H^{-1} and Li^+ are isoelectronic. Explain the difference in radii of the two species. (3 marks)

(b) The 1st and 2nd Ionisation energies of Na are 495.9 and 4,560 kJ mol^{-1}, and those of Mg are 738.1 and 1,450 kJ mol^{-1}, respectively. Explain the differences in the ionisation energies. (8 marks)

(c) Two atoms have electron configurations $1s^2\ 2s^2$ and $1s^2\ 2s^2\ 2p^1$. The 1st ionisation energies of the two atoms are 801 and 899 kJ mol^{-1}. Match each of the ionisation energies with the respective atom. Explain the choice. (6 marks)

(d) Explain the low electron affinity of Nitrogen (electron affinity ≈ 0). (3 marks)

Question FOUR

(a) State Lé Chatelier's Principle (1 mark)

(b) With initial concentrations of $[H_2]_0 = 0.86$ M, $[N_2]_0 = 0.65$ M and $[NH_3]_0 = 0.45$ M, and value of $K_c = 9.6$ at 375 °C, the synthesis of ammonia is given by the reaction;

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

(i) Calculate the reaction quotient Q_c, and determine the direction of the reaction.

(5 marks)

(ii) Explain the changes in the concentration of the reactants and product.

(4 marks)

(c) Calculate the pH of a 0.35 M solution of NH_4Cl, given $K_b = 1.8 \times 10^{-5}$. (10 marks)

Question FIVE

(a) Calculate the pH of a buffer solution made from 35.0 g of CH_3COOH and 25.6 g of CH_3COONa in 1.0 l of solution. Given $K_a = 1.8 \times 10^{-5}$. (6 marks)

(b) Calculate the quantity of $CaCO_3$ in grams that will dissolve in 1,000 ml of 0.10 M $Ca(NO_3)_2$; given $K_{sp} = 8.7 \times 10^{-9}$. [Atomic masses: N = 14, C = 12, O = 16, Ca = 40] (8 marks)

(c) Highlight the processes associated with nitrogen fixation. (6 marks).