TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE & APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MATHEMATICS AND COMPUTER SCIENCE

BACHELOR OF SCIENCE IN STATISTICS AND COMPUTER SCIENCE

ACH 4108 : CHEMISTRY

SPECIAL/ SUPPLIMENTARY EXAMINATIONS

SERIES: SEPTEMBER 2018

TIME: 2 HOURS

DATE: Pick Date Sep 2018

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;

(i) $H_3\underline{P}O_4$ (ii) $\underline{Pt}Cl_6^{2-}$ (2 marks)

(b) Give any TWO failures of Bohr's theory of the structure of the H atom. (2 marks)

(c) 0.65 g of a Na_2CO_3 solution neutralises 25 ml of a HCl solution.

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

(ii) Calculate the concentration of the HCl solution. (3 marks)

(H = 1, C = 12, O = 16, Na = 23, Cl = 35.5)

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

(e) For an electronic transition from the n = 5 to n = 2 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 x 10^{-18} J; C = 2.99 x 10^9 ms^{-1}; h = 6.63 x 10^{-34} Js).

(f) Define the following terms,

(i) Dative covalent bond (1 mark)

(ii) Hydrogen bond (1 mark)

(g) Draw a Lewis diagram for NO_2^-, showing resonance structures and formal charges (3 marks)

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

(i) (i) Differentiate the terms electron affinity and electronegativity (2 marks)

(ii) Provide guidelines for the application of electronegativity in predicting the type of bonding (3 marks)

Question TWO

(a) Provide unique quantum numbers for the valence electrons in the B (Z=5) atom. (3 marks)

(b) Write electron configurations for the following ionic species,

(i) P^{-3} (Z=15) (ii) Cr^{2+} (Z=24) (2 marks)

(c) Explain how water can be purified by ion exchange. (8 marks)

(d) Calculate the pH of a 1.5 x 10^{-3} *M* solution of HCN, given K_a = 4.9 x 10^{-10}. (7 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) Write the equilibrium reaction and expression for the solubility product for $Ca_3(PO_4)_2$. (2 marks)

(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) 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)

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) For the galvanic cell $Cd(s) \mid Cd^{2+}(1.0\ M\ Cd(NO_3)_2 \mid\mid Pb^{2+}(1.0\ M\ Pb(NO_3)_2 \mid Pb(s)$

(i) Write the half-reactions and overall balanced equation for the cell. (3 marks)

(ii) Determine the standard cell emf, given $\varepsilon^o_{Cd^{2+}/Cd} = -0.40\ V$ and $\varepsilon^o_{Pb^{2+}/Pb} = -0.13\ V$.

(3 marks)