Technical University of Mombasa

Faculty of Applied and Health Sciences

DEPARTMENT OF PURE AND APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF
BSC. BUILDING AND CIVIL, ELECTRICAL AND ELECTRONICS AND MECHANICAL & AUTOMOTIVE ENGINEERING

ACH 4130: CHEMISTRY I

SEMESTER EXAMINATION

DECEMBER 2013 SERIES 2 HOURS

Instructions to candidates:

This paper consist of FIVE questions
Answer question ONE (compulsory) and any other TWO questions

QUESTION ONE

a) State the following:

(i) Pauli exclusion principle
(ii) Hund's rule
(iii) De Broglie's theory

(6marks)

b) Calculate the speed of an electron having a de Broglie wavelength of 2.6×10^{-15}m. Given the mass of an electron as 9.11×10^{-31}Kg. **(4marks)**

c) The following equation represents the reaction between acidified dichromate and iron(II) ions:

$Cr_2O_7^{2-}(aq) + Fe^{2+}(aq) \rightarrow Cr^{3+}(aq) + Fe^{3+}(aq)$

Write the balanced equation for the:

(i) Half-reduction process **(1mark)**

(ii) Half-Oxidation process **(1mark)**

(iii) Overall redox reaction **(2marks)**

d) Calculate the pH of 0.8mol dm^{-3} of benzoic acid (C_6H_5COOH), given that the dissociation constant Ka (C_6H_5COOH) = $6.4 \times 10^{-5} moldm^{-3}$ **(3marks)**

e) Haber process is a very important industrial process for nitrogen fixation.

(i) Write the important equation for the reaction in Harber process **(1mark)**

(ii) Name the catalyst used in this process. **(1mark)**

(iii) Give the optimum temperature needed to increase the yield. **(1mark)**

f) The concentration of silver ions in a saturated solution of Ag_2CrO_4 at 25˚C is $1.8 \times 10^{-4} mol\ L^{-1}$. Determine Ksp of Ag_2CrO_4 at this temperature. **(4marks)**

g) Although H_2O and H_2S both have simple molecular structure, H_2O has an abnormal higher boiling point than H_2S. Explain. **(3marks)**

h) Given the following species: ${}_{54}Te^{2-}$

(i) Write the electronic configuration of the neutral atom. **(1mark)**

(ii) State the period and group of the neutral element. **(2marks)**

QUESTION TWO

a) Explain FOUR differences between the Bohr's model of an atom and that of modern quantum theory. **(4marks)**

b) Calculate the wavelength, in meters of the 5^{Th} line in the Paschen series of the hydrogen spectrum. **(4marks)**

c) If the position of an electron is known to be within 10^{-12}m, determine the uncertainty in its momentum. **(3marks)**

d) State the Planck's quantum theory. **(2maks)**

e) Give one everyday example to illustrate the concept of Planck's theory. **(1mark)**

f) For radiation having $\lambda = 2.0 \times 10^{-7}$m, calculate the:

(i) Frequency
(ii) Energy of the radiation
(iii) Periodic time, T

(Plank's constant $= 6.63 \times 10^{-34} JS^{-1}$, speed of light $= 3.0 \times 10^{8} ms^{-1}$)

(6marks)

QUESTION THREE

a) Determine the total valence electrons for each of the following species and them draw the Lewis structure for each:

(i) PO_2^- (P = 15, O = 8)

(ii) SF_3^+ (S = 16, F = 9)

(6marks)

b) Write the stable electronic configuration for each of the following atoms:

(i) Sc(number of protons = 21, neutrons = 23)
(ii) Cu (number of neutrons = 35, protons = 29)
(iii) ${}^{75}_{33}As$
(iv) ${}^{52}_{24}Cr$

(4marks)

c) Give the quantum number combinations for the electron in 4d orbital **(3marks)**
d) Using the quantum number combinations, work out the total number of atomic orditals available for the electron in 4p. **(4marks)**
e) State and explain which among the following pair of atoms has a lower 1st ionization energy : ${}_{33}Y$ and ${}_{14}Z$

(3marks)

QUESTION FOUR

a) Sodium hydroxide pellets were accidentally mixed with sodium chloride. 17g of the mixture were dissolved in water to make one litre of solution. $100cm^3$ of this solution was neutralized by $40cm^3$ of 0.5 M sulphuric acid.

(Na =23,) = 16, H = 1, S = 32, Cl = 35.5)

(i) Write an equation for the reaction that took place. **(1mark)**

(ii) Calculate the number of moles of the substance that reacted with sulphuric acid. **(2marks)**

(iii) Determine the number of moles in one litres of the substance that would react with sulphuric acid. **(1mark)**

(iv) Work out the mass of the unreacted substance in one litre of solution. **(2marks)**

b) For each of the equation, identify the conjugate acid –base pairs

(i) $OClO_2^- + H_3O^+ \rightleftharpoons H_2O + HOClO_2$

(ii) $SeO_4^{2-} + NH_4^+ \rightleftharpoons HSeO_4^- + NH_3$

(4marks)

c) Calculate the pH of a buffer solution made from 0.10M acetic acid and 0.10M sodium acetate. Given the Ka (acetic acid) = 1.8×10^{-5}M **(3marks)**

d) Determine the new pH when 0.01mol of HCl is added to 1.00dm^3 of the solution in 4(c) above. **(4marks)**

e) Name three enzymes involved in the N_2 cycle and state the role for each. **(3marks)**

QUESTION FIVE

a) Give FOUR difference between oxidation and reduction process. **(4marks)**

b) Indicate the oxidation number of the underlined atom: $K_2\underline{Cr}\,O_4$ **(1mark)**

c) Predict the molecular geometry of the following compounds using the valence shell Electron Pair Repulsion (VSEPR) model:

(i) H_2O

(ii) PF_5

(4marks)

d) The solubility product of Zinc chloride is 1.6×10^{-10} at 25˚C. Find its solubility in

(Zn =65, D = 35.5)

(i) Moles per litre **(4marks)**

(ii) gL^{-1} **(3marks)**

e) The solubility of $Mg(OH)_2$ in pure water is 9.57×10^{-3} gL^{-1} calculate its solubility in gL^{-1} in 0.02M Mg $(NO_3)_2$ solution. **(4marks)**