THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL
ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/1

CHEMISTRY 1

(For Both School and Private Candidates)

Time: 3 Hours **Thursday, 07th May, 2015 p.m.**

Instructions

1. This paper consists of **fourteen (14)** questions in sections A, B and C.
2. Answer **four (4)** questions from section A and **three (3)** questions from each of sections B and C.
3. Each question carries **ten (10)** marks.
4. Mathematical tables and non-programmable calculators may be used.
5. Cellular phones are **not** allowed in the examination room.
6. Write your **Examination Number** on every page of your answer booklet(s).
7. For calculations you may use the following constants:
   - Rydberg constant $R_H - 1.09678 \times 10^7\ m^{-1}$
   - Gas constant, $R = 8.31\ Jmol^{-1}\ K^{-1}$ or $0.082\ atm\ mol^{-1}\ K^{-1}\ dm^3$
   - GMV = $22.4\ dm^3$
   - 1litre = $1dm^3 = 1000\ cm^3$
   - Standard temperature = 273 K
   - Standard pressure = 760 mmHg or $1.01 \times 10^5\ Nm^{-2}$
   - Planck constant, $h = 6.63 \times 10^{-34}\ Js$
   - Velocity of light, $c = 3.0 \times 10^8\ m/s$
   - Mass of electron = $9.11 \times 10^{-31}\ kg$
   - Atomic masses: H = 1, C = 12, O = 16, F = 19.

SECTION A (40 Marks)

Answer **four (4)** questions from this section.

1. (a) State the following:
   (i) Pauli's exclusion principle.
   (ii) Aufbau building principle.
   (iii) Hund's rule of maximum multiplicity.
   (iv) Half-filled and full-filled orbital rule. **(4 marks)**

   (b) Write down the electronic configuration of each of the following species using orbital diagrams:
   (i) Cl^- (ii) K (iii) Ca^{2+} (iv) F. **(4 marks)**

   (c) Element Z occurs naturally as a mixture of ^{69}Z and ^{71}Z.
   (i) Briefly explain the significance of the numbers 69 and 71 and give a term which describes these two components in the natural element.
   (ii) If ^{69}Z and ^{71}Z have relative atomic mass of 69.8, find the percentages of ^{69}Z and ^{71}Z in a sample of Z. **(2 marks)**

2. (a) State the distribution law. **(1 mark)**

   (b) The concentration of a solute X in water was found to be 8.5 g/dm^3 at room temperature. 100 cm^3 of this solution was shaken with 50 cm^3 of methyl benzene until equilibrium was obtained. The organic layer was separated and found to contain 0.8 g of X.
   (i) Calculate the distribution coefficient of X between methyl benzene and water.
   (ii) What further mass of X would be removed from the aqueous layer if it was shaken with a further 50 cm^3 of methyl benzene?
   (iii) Calculate the mass of X extracted if 100 cm^3 of methyl benzene was used at once instead of using 50 cm^3 twice. Which is the more efficient extraction process? Give reason for your answer. **(9 marks)**

3. (a) Describe two assumptions of kinetic theory of gases that are not obeyed by real gases. **(2 marks)**

   (b) (i) Differentiate between diffusion and effusion for gases.
   (ii) Uranium and fluorine form a gaseous compound, UF_6. It is proposed that the ^{235}U and ^{238}U isotopes be separated by gaseous diffusion of the $^{235}UF_6$ and $^{238}UF_6$ compounds. Which gas would diffuse more rapidly, and by how much? **(5 marks)**

   (c) A general equation for the breakdown of glucose in a human body can be presented as follows:
   $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$.
   If 856 g of $C_6H_{12}O_6$ is consumed by a person over a certain period, what is the mass of CO_2 produced? **(3 marks)**

4. (a) Write the equilibrium constant expressions (K_c) for the following reactions:

(i) $2NO_{2(g)} + 7H_{2(g)} \rightleftharpoons 2NH_{3(g)} + 4H_2O_{(l)}$

(ii) $2ZnS_{(s)} + 3O_{2(g)} \rightleftharpoons 2ZnO_{(s)} + 2SO_{2(g)}$

(iii) $Br_{(l)} + H_{2(g} \rightleftharpoons HBr_{(g)}$

(iv) $\frac{1}{3}N_{2(g)} + H_{2(g)} \rightleftharpoons \frac{2}{3}NH_{3(g)}$

(4 marks)

(b) The equilibrium constant (K_c) for the reaction $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$ is 4.63×10^{-3} at 25° C. What is the value of K_p at this temperature?

(2.5 marks)

(c) The following equilibrium constants have been determined for hydrosulphuric acid at 25° C. $\rightleftharpoons$

$H_2S_{(aq)} \rightleftharpoons H^+_{(aq)} + HS^-_{(aq)}$; $K_c = 9.5 \times 10^{-8}$

$HS^-_{(aq)} \rightleftharpoons H^+_{(aq)} + S^{2-}_{(aq)}$; $K_c = 1.0 \times 10^{-19}$

Calculate the equilibrium constant for the following reaction at the same temperature:

$H_2S^-_{(aq)} \rightleftharpoons 2H^+_{(aq)} + S^{2-}_{(aq)}$

(3.5 marks)

5. (a) 60 cm^3 of a certain gas was collected at 60 °C and 1.05×10^5 Nm^{-2}. Calculate the volume of the gas at stp.

(3 marks)

(b) When 0.5 dm^3 of O_2 and 1.0 dm^3 of CO_2 were mixed at 27 °C, the total pressure in the vessel was found to be 1.2 atm. Calculate;

(i) partial pressure of each gas

(ii) the mass of each gas.

(7 marks)

6. (a) Give any four differences between a positive and a negative non-ideal solutions.

(4 marks)

(b) Equal moles (0.5 moles) of benzene and toluene were mixed to form an ideal solution. Calculate the fraction of benzene and toluene in the second vapour given that, $P°_{benz.} = 95.1$ mmHg and $P°_{tol.} = 28.4$ mmHg.

(6 marks)

SECTION B (30 Marks)

Answer **three (3)** questions from this section.

7. (a) 0.01 M aqueous solution of 92.5% NaCl is dissociated at 18 °C. Calculate the osmotic pressure (π) of this solution at the given temperature.

(5 marks)

(b) When 5.8 g of acetic acid (CH_3CO_2H) was dissolved in 90 g of benzene (C_6H_6) the freezing point depression was found to be 3.8 °C. Calculate the degree of association of acetic acid in benzene, given that acetic acid dimerizes in benzene and $K_f = 5.1$ °C $mol^{-1}kg^{-1}$.

(5 marks)

8. (a) State Hess's law of constant heat summation. **(1 mark)**

(b) (i) Give the difference between the standard bond dissociation energy and the standard heat of formation of a substance.

(ii) Calculate the enthalpy change for the reaction $2NH_{3(g)} \rightarrow N_{2(g)} + 3H_{2(g)}$ given that: E(N-H) = 388 kJ mol^{-1}; E(N≡N) = 944 kJ mol^{-1} and E(H-H) = 436 kJ mol^{-1}.

(9 marks)

9. (a) Giving examples, briefly explain each of the following:

(i) Hydrogen bonding

(ii) Coordinate bond

(iii) Van der Waal forces. **(3 marks)**

(b) For each of the following pairs of substances, predict which substance has a higher melting point, and give reason for each choice you make.

(i) CH_3CH_3 and CH_3OH

(ii) CO_2 and H_2

(iii) HCl and H_2O

(iv) Al and Mg

(v) Si and Na. **(5 marks)**

(c) Describe the hybridization of beryllium in beryllium chloride ($BeCl_2$). **(2 marks)**

10. (a) Distinguish between the following:

(i) atomic number from mass number

(ii) a photon from a quanta. **(2 marks)**

(b) A photon was absorbed by a hydrogen atom in its ground state and the electron was promoted to the fifth orbit. When the excited atom returned to its ground state, visible radiation and other quanta were emitted.

(i) Briefly explain the transitions made by the electron for the excited atom to return to its ground state.

(ii) Calculate the wavelength of a photon emitted during a transition from the $n_1 = 5$ state to the $n_2 = 2$ state in the hydrogen atom given that $\Delta E = 2.18 \times 10^{-18}$ $J[(\frac{1}{n_1^2} - \frac{1}{n_2^2})]$. **(8 marks)**

SECTION C (30 Marks)

Answer **three (3)** questions from this section.

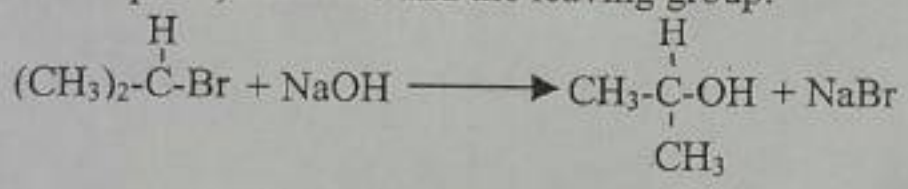
11. (a) Briefly explain each of the following as applied in organic reactions:
    (i) Positive inductive effect.
    (ii) Negative inductive effect.
    (iii) Mesomeric effect.
    (iv) Stearic factors. **(4 marks)**

    (b) Explain each of the following observations:
    (i) Addition reactions in benzene need high energy.
    (ii) Nucleophilic substitution reactions in benzene are not possible.
    (iii) Methyl group when attached to benzene ring direct another incoming group to ortho or para position.
    (iv) Nitro group when attached to benzene ring direct another incoming group to meta position. **(6 marks)**

12. Give the mechanism for the following:
    (a) Sulphonation of benzene. **(5 marks)**

    (b) Chlorination of benzene. **(5 marks)**

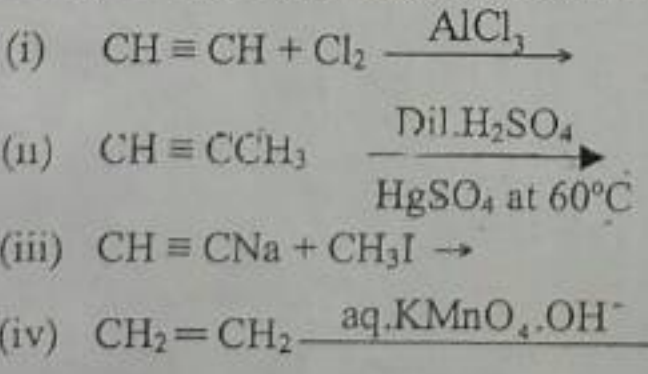
13. (a) Write the mechanism of the following substitution reaction, indicating clearly the nucleophile, substrate and the leaving group:



(2 marks)

    (b) Carry out the following conversions:
    (i) Propane to1-chloropropane.
    (ii) Propane to propene. **(2 marks)**

    (c) Complete the following reactions and name the organic product formed.



(6 marks)

14. (a) Write the open structures of five isomers of the compound C_5H_7Cl and their corresponding IUPAC names. **(5 marks)**

(b) Arrange the following compounds in the order of increasing acidity and give reason(s) for your arrangement: O_2N-C≡CH; CH_3-C≡CH; Cl-C≡CH; $(CH_3)_3$-C≡CH.

(2 marks)

(c) Suggest suitable tests to distinguish the following compounds:

(i) Propyne and propene.

(ii) 2-methylpent-2-ene and 3-methylpent-2-ene.

(iii) But-2-yne and butane. **(3 marks)**