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

132/1 **CHEMISTRY 1**
(For Both School and Private Candidates)

Time: 3 Hours **Year: 2020**

Instructions

1. This paper consists of sections A and B with a total of **ten (10)** questions.
2. Answer **all** questions in section A and **two (2)** questions from section B.
3. Each question carries **ten (10)** marks in section A and **fifteen (15)** marks in section B.
4. Mathematical tables and non-programmable calculators may be used.
5. Cellular phones and any unauthorised materials 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:
   - Rydberg constant $R_H = 1.09678 \times 10^7\ m^{-1}$
   - Gas constant, $R = 8.31\ Jmol^{-1}K^{-1}$ or $0.0821\ atm\ mol^{-1}\ K^{-1}\ dm^3$
   - GMV = $22.4\ dm^3$
   - Standard temperature = 273 K
   - Standard pressure = 760 mmHg = 1 atm = $1.05 \times 10^5\ NM^{-2} = 1.05 \times 10^5$ Pa
   - Planck's constant, $h = 6.63 \times 110^{-34}$ Js
   - Velocity of light, $c = 3.0 \times 10^8$ m/s
   - Mass of an electron = 9.11×10^{-31} kg
   - Density of water, $\rho = 1\ g/cm^3$
   - 1 mole = 1000 millimoles
   - $1\ dm^3 = 1$ litre $= 1000\ cm^3 = 10^{-3}\ m^{-3}$
   - Freezing point of water = 0ºC
   - Atomic masses: N = 14, H = 1, C = 12, O = 16, Na = 23, Cl = 35.5.

SECTION A (70 marks)

Answer **all** questions from this section.

1. (a) By using chemical equations, describe the following:
   (i) Amphoteric oxides.
   (ii) Basic oxides. **(4 marks)**

   (b) With the aid of chemical equation(s), explain how you can prepare soluble chlorides. **(4 marks)**

   (c) A student suggested a methodology to prepare aluminium trichloride ($AlCl_3$) by following the steps (i) − (iv) as follows:
   (i) Add sodium hydroxide solution to aluminium sulphate solution.
   (ii) Filter off the precipitate.
   (iii) Convert the hydroxide into a chloride by adding hydrochloric acid.
   (iv) Evaporate the solution to leave crystals of $AlCl_3$.
   Could this process work? Justify. **(2 marks)**

2. (a) Explain two detrimental effects of excessive salts in the soil. **(2 marks)**

   (b) Give four advantages of adding organic manures in the soil. **(4 marks)**

   (c) 20 g of a soil sample was shaken with shaken with 40 cm^3 of 0.1 M HCl solution. After filtering and washing the soil, the filtrate required 27 cm^3 of 0.1 M NaOH solution for complete neutralization. The total Cation Exchange Capacity (CEC) of the soil is 29 milli. eq. per 100 g of the soil sample. Calculation the Percent Base Saturation (PBS) of the soil sample. **(4 marks)**

3. (a) (i) Name two major natural sources of organic compounds. **(1 mark)**
   (ii) Briefly, explain three properties of carbon element that makes it able to form a large number of compounds. **(3 marks)**

   (b) A form six student gave the following names for various substituted aliphatic hydrocarbons:
   (i) 2-methyl-3-bromobutane,
   (ii) 3,3-dimethyl-2chlorobutane,
   (iii) 4-chloro-3-bromo-2-pentene,
   (iv) 2-methyl-4-butyne.
   The names indicate the formulae of the substituted aliphatic hydrocarbons but do not strictly obey IUPAC rules. Draw the structure suggested by the incorrect names and assign the correct name for each compound. **(4 marks)**

   (c) Explain each of the following observations:
   (i) Methylpropane has a lower boiling point than butane although both have the same molecular mass.
   (ii) Ignition sources such as smoking are not allowed at petrol stations. **(2 marks)**

4. (a) Diborane, (B_2H_6) is very reactive such that it was once considered as a possible rocket fuel for U.S space programs. The overall equation for the synthesis of diborane is:
   $2B(s) + 3H_2(g) \rightarrow B_2H_6(g)$

Use the following data to calculate the enthalpy change of formation of B_2H_6 from its elements:

$2B(s) + 3/2O_2(g) \rightarrow B_2O_3(s)$ $\Delta H = -1273kJ$

$B_2H_6(s) + 3O_2(g) \rightarrow B_2O_3(s) + 3H_2O(g)$ $\Delta H = -2035kJ$

$H_2(g) + ½O_2(g) \rightarrow H_2O(l)$ $\Delta H = -286\ kJ$

$H_2O(l) \rightarrow H_2(g)$ $\Delta H = -44\ kJ$ **(5 marks)**

(b) When 100 cm^3 of 1 M KOH and 100 cm^3 of 1 M HCl were mixed in a calorimeter, temperature rose by 6.25 K. Given that the heat capacity of the calorimeter was 95 J/K and specific heat capacity of the solution mixture was 4.2 J/gK, calculate the standard enthalpy of neutralization. Assume that the density of the solution is equal to the density of water. **(5 marks)**

5. (a) (i) State four postulates of Dalton's atomic theory. **(2 marks)**

(ii) Why different atoms have different chemical properties. Briefly explain. **(1 mark)**

(b) Write the chemical symbol (${}^{Z}_{A}X$) and orbital electronic configuration for the atoms described in the following table:

S/n	Number of Neutrons	Number of Electrons
(i)	13	11
(ii)	7	8
(iii)	17	18
(iv)	16	16

(4 marks)

(c) Calculate the minimum energy required to remove an electron from the hydrogen atom in its ground state. **(3 marks)**

6. (a) Differentiate:

(i) electrovalent bond from octet rule.

(ii) lone pair from bonding pair of electrons. **(2 marks)**

(b) Using sketches, briefly explain three possible overlaps that can occur during sigma bond formation. **(3 marks)**

(c) Give two reasons for the observed difference in bond strength between sigma and pi bonds in compounds. **(2 marks)**

(d) Predict the geometry of ammonia, basing on the Valence Shell Electron Pair Repulsion (VSEPR) theory. **(3 marks)**

7. (a) A 0.25 moles of air has entered a diesel engine at a pressure of $1.05x10^5$ Pa and a temperature of 27ºC. Assuming that air is ideal, calculate:

(i) the volume it occupies. **(3 marks)**

(ii) its temperature, immediately after compression to one twentieth of its original volume where the pressure rises to 7.0×10^6 Pa. **(3 marks)**

(b) A 42 g of nitrogen gas and 8 g of hydrogen gas are mixed in a 10 litre vessel at 20ºC. Calculate the partial pressure of each gas and the total pressure of the gas mixture. **(4 marks)**

SECTION B (30 Marks)

Answer **two (2)** questions from this section.

8. (a) (i) Differentiate between cryoscopic constant and ebullioscopic constant. **(2 marks)**
(ii) Derive an expression relating the van't Hoff factor (*i*) and the degree of dissociation (α). **(2 marks)**
(iii) Briefly, explain the effect of degree of dissociation of a solute on the boiling point of a solution. **(1 mark)**

(b) What mass of ethylene glycol, $C_2H_6O_2$, the main component of antifreezing agent which must be added to a 10.0L of water to produce a solution for use in a car radiator, that freezes at -23.3ºC? Assume that the density of water is exactly 1 g/mL and cryoscopic constant is 1.86ºCkg/mol. **(4 marks)**

(c) A 0.120 g of haemoglobin, the protein which carries oxygen in the blood was dissolved in 200 cm^3 of benzene at 20ºC. The solution exerted an osmotic pressure of 25.6 Pa. Find the relative molecular mass of haemoglobin. **(3 marks)**

(d) A 1% solution of sodium chloride freezes at -0.604ºC. Calculate the degree of dissociation of the sodium chloride if the molal freezing point depression constant for water is 1.86ºC kg/mol. **(3 marks)**

9. (a) (i) Briefly explain the effect of change of pressure to a system at equilibrium. **(2 marks)**
(ii) Why does a Coca cola soda fizz out when its bottle is opened? Give a reason. **(1 mark)**

(b) Consider the following equilibrium:
$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(l)$
Yellow Orange
What would be observed when:
(i) dilute NaOH is added to the equilibrium mixture?
(ii) dilute HCl is added to the equilibrium mixture? **(4 marks)**

(c) The following equilibrium was established during the preparation of phosphorus(V) pentachloride:
(i) Calculate the equilibrium constant for this reaction at 127ºC if the equilibrium concentrations observed at this temperature were 0.034 mol/L for ammonia, 0.85 mol/L for nitrogen and 0.031 mol/L for hydrogen.
(ii) Using the same equilibrium concentrations in (d) (i), calculate the equilibrium constant at 127ºC for the equilibrium:
$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$ **(6 marks)**

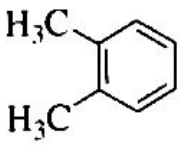
10. (a) Why benzene though highly unsaturated, it does not undergo addition reactions? Briefly explain. **(4 marks)**

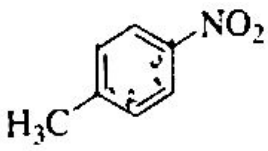
(b) Name two examples in each of the following chemical groups:
(i) *Ortho-para* directors.
(ii) *Meta* directors. **(2 marks)**

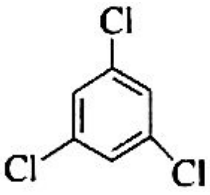
(c) Why *ortho-para* directing groups are called activating groups and *meta*-directing groups are called deactivating groups? Briefly explain. **(4 marks)**

(d) Determine the structural formulae of the following compounds:
(i) 1,3,5-trimethylbenzene.
(ii) (1-methylethyl)benzene. **(2 marks)**

(e) Give the IUPAC names of the following aromatic compounds:

(i) 

(ii) 

(iii) 

(3 marks)