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

132/2

CHEMISTRY 2
(For Both School and Private Candidates)

Time: 3 Hours **Year: 2022**

Instructions

1. This paper consists of a total of **six (6)** questions.
2. Answer **five (5)** questions.
3. Each question carries **twenty (20)** marks.
4. Mathematical tables and non-programmable calculators may be used.
5. Cellular phones and any unauthorized 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 constants:

   Gas constant, R = 8.31 J mol^{-1} K^{-1} or 0.082 atm mol^{-1} K^{-1} dm^3
   GMV = 22.4 dm^3
   Standard temperature = 273 K
   Standard pressure = 760 mm Hg = 1 atm = 1.0 x 10^{-5} N m^{-2}
   Velocity of light, c = 3.0 x 10^8 m/s
   1 Faraday = 96,500 C mol^{-1}
   Atomic masses: H = 1, C = 12, O = 16, Na = 23, K = 39, Mn = 55, Br = 80

1. (a) (i) A solid **Y** is added to a mixture of benzene and water. After shaking well and allowing the mixture to equilibrate, 10 cm^3 of the benzene layer was found to contain 0.13 g of **Y** while 100 cm^3 of the aqueous layer contained 0.22 g of **Y**. Calculate the value of the distribution coefficient of **Y** between benzene and water.

(ii) Comment on the solubility of **Y** in benzene and water with respect to the distribution coefficient you have obtained in 1 (a) (i). **(08 marks)**

(b) (i) What are the two applications of fractional distillation? Explain briefly.

(ii) Calculate the percentage by mass of bromobenzene (C_6H_5Br) in the distillate when a mixture of bromobenzene and water distills in steam at 95 °C. The vapour pressures of bromobenzene and water at 95 °C are 1.59×10^4 and 8.50×10^4 N m^{-2} respectively. **(06 marks)**

(c) Heptane (C_7H_{16}) and octane (C_8H_{18}) form an ideal solution. At 373 K, the vapour pressures of pure heptane and octane were 105.2 kPa and 46.8 kPa respectively. Calculate the vapour pressure of the mixture of 26.0 g of heptane and 35.0 g of octane. **(06 marks)**

2. (a) Calculate the pH of a sample of pure water at 25 °C. Given $K_W = 10^{-14}$ mol^2/dm^6 at 25 °C. **(04 marks)**

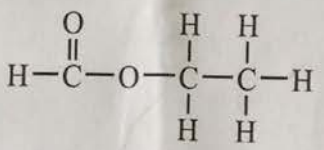
(b) A 500 cm^3 of 0.1 M aqueous solution of CH_3COOH (acetic acid) were mixed with 500 cm^3 of 0.1 M HCl solution. If 3 g of NaOH are added to the mixture, calculate the pH of the mixture before and after addition of NaOH, assuming that no change in volume occurs on mixing. **(06 marks)**

(c) (i) Although lead(II) chloride is sparingly soluble in pure water, it is soluble in concentrated hydrochloric acid. Explain briefly.

(ii) A chemist wanted to separate Al^{3+} and Zn^{2+} using fractional precipitation method. In the first experiment, NH_4OH was added and both Al^{3+} and Zn^{2+} precipitated. In the second experiment, NH_4OH was added followed by addition of NH_4Cl and only Al^{3+} precipitated. Comment briefly on the results obtained in the second experiment. **(05 marks)**

(d) Equal volumes of 0.025 mol/dm^3 barium nitrate and 0.010 mol/dm^3 sodium fluoride were mixed together. Show whether the solution is saturated, super saturated or unsaturated (K_{sp} value of BaF_2 is 1.7×10^{-6} mol^3/dm^9). **(05 marks)**

3. (a) Compound **Q** is commonly added to foods to give them rum flavour. It has the following structural formula:



(i) To which class of organic compounds does the compound **Q** belong?

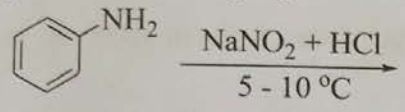
(ii) How would you synthesize compound **Q** from ethanol and methanol and any other suitable inorganic reagent?

(iii) What is the IUPAC name of compound **Q**?

(iv) Compound **Q** can react with NaOH in presence of heat. How can you represent this reaction using a chemical equation? **(08 marks)**

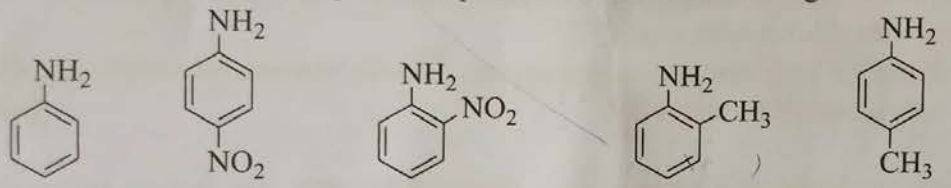
(b) Briefly, comment on the following observations:
(i) The boiling point of ethanoic acid is higher than that of ethanol.
(ii) Methylamine is a stronger base than ammonia.
(iii) Trimethylamine and *n*-propylamine have the same molecular mass but the former boils at a lower temperature (276 K) than the later (322 K). **(06 marks)**

(c) Complete the following organic reactions:

(i) 

(ii) $CH_3CH_2NH_2 + CHCl_3 + KOH \xrightarrow{\text{alcohol}}$ **(04 marks)**

(d) Arrange the following organic compounds in order of increasing their basic strength.



(02 marks)

4. (a) During a tour to one of the emerging local industries in Tanzania, it was noticed that some of the machine parts made up of iron were corroding. What do you think would be the factors affecting the extent of corrosion? Briefly, explain three factors only. **(06 marks)**

(b) By using half-reaction method, balance the following redox reaction if it takes place in an acidic medium: $Cr_2O_7^{2-}(aq) + HNO_2(aq) \rightarrow Cr^{3+} + NO_3^-(aq)$. **(04 marks)**

(c) Ethanedioc acid crystal, $H_2C_2O_4.2H_2O$, weighing 0.95 g was dissolved in a 0.25 dm^3 of distilled water. A 25.0 cm^3 of the resulting solution required 33.0 cm^3 of potassium permanganate(VII) solution for complete reaction during a titration experiment. Calculate the concentration of potassium permanganate(VII) solution. **(06 marks)**

(d) With a reason, predict if the reaction will occur when iodine and bromine are added to a solution containing ions of iodide and bromide both maintained at 1 M. The electrode potential for the reactions are given as follows:

$I_2 + 2e \rightarrow I^-$ $E° = +0.54\,V$

$Br_2 + 2e^- \rightarrow 2Br^-$, $E° = +1.08\,V$ **(04 marks)**

5. (a) (i) What is the difference between periodicity and diagonal relationship?
(ii) How is tin reduced by thermal method in the reverberator furnace? Explain briefly while supporting your answer with appropriate chemical equations. **(04 marks)**

(b) "Lithium and magnesium relate diagonally in a periodic table of elements." By giving three reasons, briefly justify this statement. **(06 marks)**

(c) The metallic characters of the elements change across the period. Illustrate this concept with reference to chlorides and hydrides of the elements of period 3. **(10 marks)**

6. (a) By giving a reason, arrange the following complex compounds in order of increasing their magnetic properties.
$[MnCl_4]^{2-}$; $[FeF_6]^{4-}$; $[Fe(CN)_6]^{4-}$
(02 marks)

(b) Briefly explain the following:
(i) A concentrated aqueous copper(II) chloride solution is bright green in color but changes to light blue when diluted with water.
(ii) The *d* orbitals for both zinc and copper contain paired electrons, but copper is considered a transition element while zinc is not. **(04 marks)**

(c) You have been employed as a chemist in a chemical industry which plan to use transition elements as catalysts in their production. Briefly, explain four applications/uses of transition elements as catalysts. Support your answer with one chemical equation in each case. **(04 marks)**

(d) (i) With an example in each case, explain two types of polymers based on physical properties.
(ii) Why Tanzania government banned the use of polymers obtained from ethylene monomers? Briefly, explain.
(iii) How does the structural differences of High Density Polythene (HDP) and Low Density Polythene (LDP) account for their differences in behaviour and nature? **(10 marks)**