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)

Year: 2023

Time: 3 Hours

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. All writing must be in **blue** or **black** ink **except** drawing which must be in pencil.
6. Cellular phones and any unauthorised materials are **not** allowed in the examination room.
7. Write your **Examination Number** on every page of your answer booklet(s).
8. For calculations you may use the following:
   - Gas constant, $R = 8.31\ J\ mol^{-1}\ K^{-1}$ or $0.0821\ atm\ mol^{-1}\ K^{-1}\ dm^3$
   - GMV = $22.4\ dm^3$
   - Standard temperature = 273 K
   - Standard pressure = 760 mm Hg = $1.0 \times 10^5\ N\ m^{-2}$ = 1 atm
   - Planck's constant, $h = 6.63 \times 10^{-34}\ J\ s$
   - Velocity of light, $c = 3.0 \times 10^8\ m/s$
   - Mass of an electron = $9.11 \times 10^{-31}\ kg$
   - Atomic masses: H = 1, C = 12, N = 14, O = 16, Cl = 35.5, Ca = 40

SECTION A (70 Marks)

Answer **all** the questions in this section.

1. (a) A person swallowed a drop of liquid oxygen, O_2 (l), which has a density of 1.149 g/cm^3. Assuming the drop has a volume of 0.050 cm^3, calculate the volume of a gas that will be produced in the person's stomach at body temperature (37°C) and a pressure of one (1) atmosphere. **(03 marks)**

   (b) A compound contains only nitrogen and hydrogen and is 87.4% nitrogen by mass. A gaseous sample of the compound has a density of 0.977 g/L at 710 mmHg and 100 °C. Determine the molecular formula of the compound. **(04 marks)**

   (c) A total volume of 2.50×10^2 cm^3 chlorine gas was collected over water at 20 °C and a total pressure of 1 atm. Calculate the mass of chlorine collected at this temperature if the vapour pressure of water was 17.5 mm Hg. **(03 marks)**

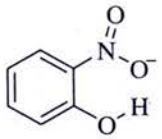
2. (a) Comment briefly on the following observations:
   (i) Sodium chloride solution freezes at a lower temperature than that of pure water but boils at higher temperature than pure water.
   (ii) A driver adds ethylene glycol to water in a car radiator during winter season.
   (iii) The blood cells which are isotonic with 0.9% sodium chloride solution are placed in 1.2% sodium chloride solution.
   (iv) When dehydrated fruits and vegetables are placed in water, they slowly swell and return to the original forms. **(04 marks)**

   (b) (i) Eighteen grams (18 g) of glucose, $C_6H_{12}O_6$ (molar mass = 180 g/mol) are dissolved in 1 kg of water in a sauce pan. At what temperature will this solution boil? Given the K_b for water = 0.52 kg/mol. **(03 marks)**

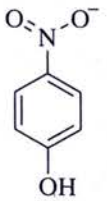
   (ii) Calculate the elevation in boiling point that is expected for an alcohol when 5 g of urea (molar mass 60 g/mol) are dissolved in 75 g of it. Given the molal elevation constant for the alcohol = 1.15 K/m. **(03 marks)**

3. (a) What are the two conditions necessary for the formation of hydrogen bonding? Briefly explain. **(02 marks)**

   (b) Study the chemical structures of compounds **I** and **II** and answer the questions that follow while giving one reason in each case:



I



II

   (i) What type of hydrogen bonding is exhibited in each compound?

(ii) Which of the two compounds is expected to have higher melting point than the other?

(iii) Which compound is likely to be more soluble in a polar solvent? **(04 marks)**

(c) Indicate the types of bonds present in NH_4NO_3 and state the mode of hybridization of the N atom in the NO_3^- ion. **(04 marks)**

4. (a) All radiations are associated with wave nature and differ from one another in terms of wavelength, frequency, velocity and energy. Give the relationship between the following:

(i) Frequency and wavelength

(ii) Wavelength and wavenumber

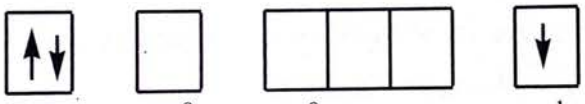
(iii) Energy and frequency

(iv) Energy and wavelength **(04 marks)**

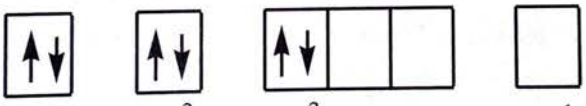
(b) Indicate whether the following electronic configurations are possible or impossible. For the impossible ones, specify the rules which have been violated.

(i)

(ii)



(iii)



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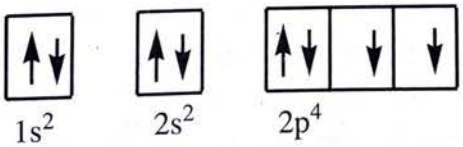
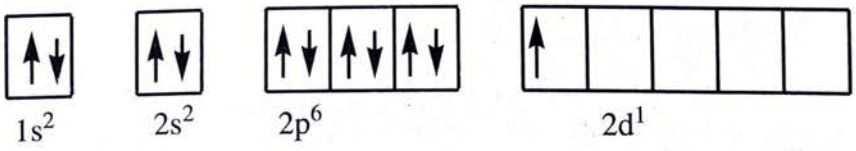


(v)



(05 marks)

(c) How many orbitals are there in each of the following sub-shells?

(i) 2*p*

(ii) 3*d* **(01 mark)**

5. (a) In the process of manufacturing chemicals, in one of the emerging chemical industries in Tanzania, a Chemist performed the following activities:

(i) Exposed sodium metal to air followed by addition of water.

(ii) Burned sodium metal in air followed by addition of water.

Briefly, explain the chemical processes that took place while supporting your answer with balanced chemical equations in each case. **(04 marks)**

(b) Using balanced chemical equations, describe the reactions between the oxides of lead, aluminium and calcium with dilute;
(i) Sulphuric acid
(ii) Nitric acid **(06 marks)**

6. (a) Differentiate between the following terms:
(i) Born-Haber cycle and enthalpy of formation.
(ii) Heat of neutralization and heat of solution. **(03 marks)**

(b) You are given an equation representing the hydrogenation of ethene as $C_2H_4(g)+H_2(g)\rightarrow CH_3CH_3(g)$. What would be the value for standard enthalpy of hydrogenation of ethene (in kJ) if the bond enthalpies were: C–H = 416; C=C = 612; C–C = 348 and H–H = 436? **(07 marks)**

7. (a) Using one chemical test, distinguish the following organic compounds:
(i) $CH_3CH{=}CH_2$ and $CH_3CH_2CH_3$
(ii) $CH_3C{\equiv}CCH_3$ and $CH_3CH_2C{\equiv}CH$ **(04 marks)**

(b) Predict the major product in each of the following organic reactions:
(i) $CH_3C\equiv CCH_3(g)+H_2O(g)\xrightarrow[Hg/H_2SO_4]{H_2SO_4}$
(ii) $CH_3CH_2Br+Na\xrightarrow{\text{dry ether}}$
(iii) $CH_3CH_3+Conc.HNO_3\xrightarrow{heat}$
(iv) $CH_3CH{=}CH_2+Br_2\xrightarrow{U.V.\ light}$ **(04 marks)**

(c) A form six student wanted to arrange the following organic compounds in order of increasing acidity of their terminal hydrogen atoms.
$CH{\equiv}CH$; $CH_3C{\equiv}CH$; $(CH_3)_3CC{\equiv}CH$; $ClC{\equiv}CH$; $NO_2C{\equiv}CH$
Suggest a correct sequence required by the student and give two reasons for your choice of arrangement. **(02 marks)**

SECTION B (30 Marks)

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

8. (a) (i) "A chemical system at equilibrium is dynamic." Explain briefly the meaning of this statement. **(01 mark)**
(ii) The equilibrium constant, K_p for the reaction $CCl_4(g)\rightarrow C(s) + 2Cl_2(g)$ is 0.76 atm at 978 K. Calculate the initial pressure of carbon tetrachloride that will

produce a total equilibrium pressure of 1.2 atm at 978 K. **(04 marks)**

(b) (i) Why the solubility of CO_2 in soft drinks like Coca-cola decreases with rise in temperature? Briefly, explain.

(ii) What happens to equilibrium in a reversible reaction if a catalyst is added to it? Explain briefly.

(iii) What happens to equilibrium constant of an exothermic reaction if temperature is raised? Explain briefly. **(03 marks)**

(c) When a yellow solution of iron(III) chloride and a colourless solution of potassium thiocyanate (KSCN) are mixed in a test tube, a red colour appears according to the following equilibrium:

$$Fe^{3+}(aq) + SCN^{-}(aq) \rightleftharpoons \underset{\text{red solution}}{[Fe(SCN)]^{2+}}(aq)$$

(i) What would be the effect on Fe^{3+} ions upon addition of KSCN to the equilibrium?

(ii) What would happen to the equilibrium position when the pressure of the system was to be doubled? Briefly, explain.

(iii) The red colour faded when the test tube containing the equilibrium mixture was placed in an ice-water bath. Briefly explain whether the value of K_c for this reaction is high or low and whether the reaction is exothermic or endothermic. **(07 marks)**

9. (a) After a successful completion of your Secondary Education, some farmers in your area of residence invite you to give a talk as far as the concept of Soil Chemistry is concerned. Briefly, explain each of the following terms while citing one example in each case:

(i) Soil reaction
(ii) Soil colloids
(iii) Liming
(iv) Organic fertilizers
(v) Artificial fertilizers **(05 marks)**

(b) Why is it necessary to measure soil pH? Briefly, explain by giving two reasons. **(04 marks)**

(c) A farmer was advised to supply 200 kg of nitrogen on the paddy farm. What would be the mass of a fertilizer with 60% by mass $Ca(NO_3)_2$ which the farmer has to buy in order to meet the nitrogen requirements for the farm? **(06 marks)**

10. (a) (i) What are the two effects of substituent groups on the reactivity of benzene ring? Briefly, explain.

(08 marks)

(ii) By giving one example in each case, briefly justify the statement "Despite the fact that both benzene and alkenes are unsaturated hydrocarbons, benzene undergoes electrophilic substitution reactions whereas alkenes undergo electrophilic addition reactions."

(03 marks)

(b) Why do activators when attached to benzene ring direct the incoming electrophile to *ortho* and *para* positions? Briefly, explain.

(02 marks)

(c) Why are the products of nitration of methylbenzene obtained at a shorter time than those of sulphonation of benzene? Explain briefly supporting your answer with a chemical equation in each case.

(02 marks)

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132/2 **CHEMISTRY 2**

(For Both School and Private Candidates)

Time: 3 Hours **Year: 2023**

Instructions

1. This paper consists of a total of **six (6)** questions.
2. Answer a total of **five (5)** questions.
3. Each question carries **twenty (20)** marks.
4. Mathematical tables and non-programmable calculators may be used.
5. All writing must be in **blue** or **black** ink **except** drawing which must be in pencil.
6. Cellular phones and any unauthorised materials are **not** allowed in the examination room.
7. Write your **Examination Number** on every page of your answer booklet(s).
8. 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 = 22,400 cm^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}

Answer a total of **five (5)** questions.

1. (a) (i) Can azeotropic mixtures be separated by distillation? Briefly, explain.
(ii) Mixing of acetone with chloroform takes place with reduction in volume. Identify the type of deviation from Raoult's law. **(04 marks)**

(b) Two liquids **M** and **N** are mixed to form an ideal solution. The vapour pressure of the solution containing 3 moles of **M** and 1 mole of **N** is 550 mm Hg. When 4 moles of **M** and 1 mole of **N** are mixed, the vapour pressure of the solution formed is 560 mm Hg. What will be the vapour pressure of the pure **M** and pure **N** at this temperature? **(06 marks)**

(c) (i) Briefly, explain five conditions that govern the distribution law.
(ii) The experiment was set to assess the solubility of succinic acid in water and ether at 15 °C. It was found that, 20 cm^3 of the ether layer contained 0.092 g of the acid. If the distribution coefficient for succinic acid between ether and water is 5.2, find the weight of the acid which was present in 50 cm^3 of the aqueous solution when the experiment was left at equilibrium. **(10 marks)**

2. (a) Comment briefly on the following statements:
(i) Lewis concept of acids and bases overruled Arrhenius concepts of acids and bases.
(ii) HSO_4^- , is an amphiprotic.
(iii) When rain is accompanied by a thunderstorm, the collected rain water will have a pH value slightly lower than that of rain water without thunderstorm. **(06 marks)**

(b) (i) Calculate the pH of a mixture when 1 cm^3 of a 0.5 M H_2SO_4 is mixed with 2 cm^3 of 0.1 M HCl, provided that no reaction occurs in the mixture.
(ii) A 0.1 M ethanoic acid solution contains 0.001 M H_3O^+ . What would be the K_a for this acid? **(08 marks)**

(c) How much volume of a 0.1 M HCN should be added to a 50 cm^3 of 0.2 M NaCN solution to prepare a buffer solution with a pH value of 4.91? (pK_a of HCN is 4.76). **(06 marks)**

3. (a) Write the IUPAC name of each of the following organic compounds:
(i) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CO-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3$
(ii) $\underset{\displaystyle C_6H_5}{\underset{|}{CH}}=CH-CHO$ **(02 marks)**

(b) (i) An organic compound **E** with molecular formula $C_9H_{10}O$ forms 2,4-dinitrophenylhydrazine (2, 4-DNP) derivative. Also, it reduces Tollen's reagent and undergoes Cannizzaro's reaction. Upon vigorous oxidation, compound **E** gives 1,4-benzene dicarboxylic acid. Determine the chemical structure of compound **E**.

(ii) Why aldehydes and ketones have lower boiling points than their corresponding alcohols and carboxylic acids? Explain briefly.

(iii) A compound **B** (C_2H_4O) on oxidation gives compound **C** ($C_2H_4O_2$). Compound **B** undergoes haloform reaction. On treatment with HCN, compound **B** forms a product **Z** which on hydrolysis, gives 2-hydroxypropanoic acid. Write the equations for all the reactions involved. **(08 marks)**

(c) Briefly explain the following observations:

(i) Methylamine has lower boiling point than methanol.

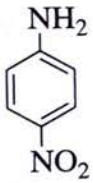
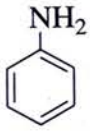
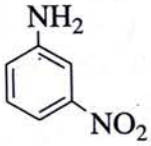
(ii) Aniline does not undergo Friedel-Crafts alkylation. **(04 marks)**

(d) (i) Identify the structures of compounds **A**, **B**, **C** and **D** in the following sequential conversions:

$$\mathbf{A} \xrightarrow[0\text{ - }5\ ^{o}C]{NaNO_2/HCl} CH_3OH \xrightarrow{SOCl_2} \mathbf{B} \xrightarrow{KCN}$$

$$\mathbf{C} \xrightarrow{LiAlH_4} \mathbf{D}$$

(ii) Giving reasons, arrange the following organic compounds in decreasing order of basic strengths.



CH_3NH_2 , NH_3 and


(iii) How ethylamine can be prepared from propionic acid? Give two steps. **(06 marks)**

4. (a) Given the following complex compound $K_3[Fe(NH_3)_6]$;

(i) Give the IUPAC name of the compound.

(ii) What is the number of electrons in the *d*-orbital in the central metal atom?

(iii) Give the geometric structure and hybridization of the complex.

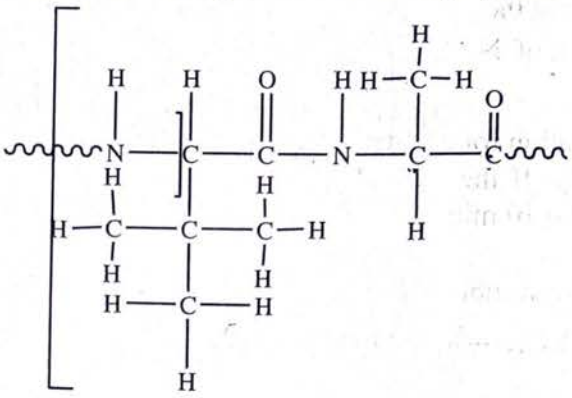
(iv) Is the complex cationic, anionic or neutral? Briefly, explain. **(04 marks)**

(b) Briefly, comment on the following statements:

(i) Silver nitrate can react with $[Cu(NH_3)_5Cl]Cl$ but not with $[Cu(NH_3)_4Cl_2]$

(ii) The complex compounds of cobalt have different colours; $[Co(CN)_6]^{3-}$ is Yellow, $[Co(NH_3)_6]^{3+}$ is orange while $[CO(H_2O)_6]^{3+}$ is blue. **(05 marks)**

(c) Protein is the polymer of amino acid produced naturally by plants and has the formula;



(i) Name the polymer.
(ii) Suggest two monomers which might have been used to synthesize this polymer.
(iii) Is this an addition polymer or condensation polymer? Give reasons for your answer.
(iv) Write the reaction equation to show how this polymer is formed. **(06 marks)**

(d) (i) Suppose you are a chemist in one of the synthetic industries and you are required to synthesize a polymer using acrylonitrile (CH_2=CH-CN) monomers. What type of polymerization process will you employ in order to synthesize the required polymer? Give a reason for your answer.
(ii) With an example in each, distinguish homopolymer from co-polymer. **(05 marks)**

5. (a) Briefly describe four characteristics of *p*-block elements. **(04 marks)**

(b) In four ways, briefly explain the factors affecting ionization energy. **(04 marks)**

(c) How do oxides of period 3 elements react with water? Explain briefly and support your answer with appropriate chemical equations. **(08 marks)**

(d) You have been asked to extract sodium metal from sea water through electrolysis. What will be the draw back and how would you overcome it? Explain briefly and support your answer with appropriate chemical equations. **(04 marks)**

6. (a) The decomposition of dinitrogen pentoxide is of first order being governed by the reaction equation $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$. When this reaction was allowed to proceed at 40 °C, the following data were collected:

$[N_2O_5]$ (M)	Time (min)
0.400	0.00
0.289	20.0
0.209	40.0
0.151	60.0
0.109	80.0

Calculate;

(i) The rate constant at the given temperature without using graph.

(ii) The concentration of N_2O_5 after 10 minutes. **(10 marks)**

(b) In the Arrhenius equation for a certain reaction, the values of **A** and $\mathbf{E_a}$ are 4×10^{13} / s and 98.6 kJ mol^{-1}, respectively. If the reaction is of first order, calculate the temperature at which its half-life period will be 10 min. **(05 marks)**

(c) The following data were obtained during the first order thermal decomposition of SO_2Cl_2 at constant volume, $SO_2Cl_2 \xrightarrow{\Delta} SO_2(g) + Cl_2(g)$.

Experiment	Time (s^{-1})	Total pressure/atom
1	0	0.5
2	100	0.6

Calculate the rate of the reaction when total pressure is 0.65 atmosphere. **(05 marks)**

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132/3A

CHEMISTRY 3A
ACTUAL PRACTICAL A
(For Both School and Private Candidates)

Time: 3:20 Hours **Year: 2023**

Instructions

1. This paper consists of **three (3)** questions. Answer **all** the questions.
2. Question number **one (1)** carries **20** marks and the other **two (2)** carry **15** marks each.
3. Qualitative Analysis Guide (QAG) sheet authorised by NECTA may be used.
4. Mathematical tables and non programmable calculators may be used.
5. All writing must be in **blue** or **black** ink **except** drawing which must be in pencil.
6. Cellular phones and any unauthorised materials are **not** allowed in the examination room.
7. Write your **Examination Number** on every page of your answer booklet(s).
8. You may use the following atomic masses:

   H = 1, C = 12, O = 16, S = 32, Na = 23.

1. You are provided with the following solutions:

T1: A solution containing a mixture of NaOH and Na_2CO_3;

T2: 0.2 M hydrochloric acid;

POP: Phenolphthalein indicator;

MO: Methyl orange indicator.

Procedure

(i) Pipette 20 or 25 cm^3 of **T1** into a clean conical flask.

(ii) Add 3 drops of **POP** into **T1** in (i) and titrate the mixture against **T2** until a colour change is observed.

(iii) Record the first titre value.

(iv) After the first end point in step (ii), add 3 drops of **MO** in the solution mixture and continue titrating until the second colour change is observed.

(v) Record the second titre value.

(vi) Repeat the procedures (i) to (v) three times. Record your results as shown in Table 1.

Table 1: Table of Results

Burette Readings (cm^3)	Pilot	1	2	3
Second end point				
First end point				
Initial reading				
First titre volume				
Second titre volume				

Summary

_____ cm^3 of **T1** required _____ cm^3 of **T2** in presence of **POP** and _____ cm^3 of **T2** in presence of **MO** for complete reaction.

Questions

(a) Explain the colour change observed for the reaction taking place between:

(i) **T1** and **T2** in the presence of **POP**.

(ii) **T1** and **T2** in the presence of **MO**.

(b) Write a balanced chemical equation for the reaction taking place in:

(i) procedure (ii).

(ii) procedure (iv).

(c) Calculate;

(i) the concentration of sodium carbonate in g/dm^3.

(ii) the concentration of sodium hydroxide in g/dm^3.

(iii) the percentage composition of each component in **T1**.

2. You are provided with the following:

P1: A solution containing 49.6 g/ dm^3 of $Na_2S_2O_3.5H_2O$;

P2: Dilute HCl;

Distilled water;

A white plain paper marked **X**;

Stop watch/clock.

Procedure

You are required to investigate the effect of concentration of sodium thiosulphate on the rate of reaction between sodium thiosulphate and hydrochloric acid using the following steps:

(i) Place a 50 cm^3 beaker on top of the mark **X** in such a way that, the mark is clearly seen through the bottom of the beaker.

(ii) Measure 10 cm^3 of solution **P1** and pour it into a beaker in (i). Then, add 5 cm^3 of **P2** and immediately start the stop watch. Stir the mixture gently and record the time taken for the disappearance of the mark **X**.

(iii) Repeat the procedure (ii) using:

- 8 cm^3 of **P1**, 2 cm^3 of water and 5 cm^3 of **P2**.
- 6 cm^3 of **P1**, 4 cm^3 of water and 5 cm^3 of **P2**.
- 4 cm^3 of **P1**, 6 cm^3 of water and 5 cm^3 of **P2**.

(iv) Record your results in a tabular form as follows:

Volume of P1 (cm^3)	**Volume of Distilled Water (cm^3)**	**Volume of P2 (cm^3)**	**[P1] (mol/dm^3)**	**t (Sec)**	**1/t (Sec^{-1})**	**[P1] × t (mol/dm^3Sec)**

Questions

(a) Plot a graph of [**P1**] (mol/dm^3) against time, t (sec).

(b) Plot a graph of 1/t (sec^{-1}) against [**P1**] (mol/dm^3).

(c) Study the results and the graphs then answer the following questions:

(i) What is the effect of concentration of $Na_2S_2O_3$ on the rate of reaction?
(ii) What is the order of reaction with respect to $Na_2S_2O_3$?
(iii) How did you reach your conclusion in (c) (ii)?

(d) Comment on the value of the product of concentration and time; that is [**P1**] × t.

3. You are provided with sample **U** containing **two cations** and **one anion**. Perform the experiments given in Table 2 and record the observations. Make appropriate inferences and hence identify the two cations and anion.

Table 2: Experimental Table

S/n	Experiments	Observations	Inferences
(a)	Observe sample **U**.		
(b)	Heat a small portion of the sample in a dry test tube.		
(c)	Perform a flame test.		
(d)	Add concentrated sulphuric acid to a small portion of the sample.		
(e)	To the small portion of solution of the sample, add dilute sodium hydroxide.		
(f)	To the small portion of the solution of the sample add dilute HCl followed by hydrogen sulphide. Filter the precipitates to obtain filtrate and residue then proceed as follows:		
	(i) To the filtrate, add potassium hexacyanoferrate(II).		
	(ii) Dissolve the residue in aqua regia and then add excess ammonia solution.		
(g)	To the small portion of the solution of the sample, add dilute nitric acid followed by silver nitrate.		

Questions

(i) Write the molecular formula for the sample.
(ii) What are the cations and anion in the sample?

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132/3B

CHEMISTRY 3B
ACTUAL PRACTICAL B
(For Both School and Private Candidates)

Time: 3:20 Hours **Year: 2023**

Instructions

1. This paper consists of **three (3)** questions. Answer **all** the questions.
2. Question number **one (1)** carries **20** marks and the other **two (2)** carry **15** marks each.
3. Qualitative Analysis Guide (QAG) sheet authorised by NECTA may be used.
4. Mathematical tables and non programmable calculators may be used.
5. All writing must be in **blue** or **black** ink **except** drawing which must be in pencil.
6. Cellular phones and any unauthorised materials are **not** allowed in the examination room.
7. Write your **Examination Number** on every page of your answer booklet(s).
8. You may use the following constants:
   - Atomic masses: H = 1, C = 12, O = 16, S = 32, Na = 23, K = 39, Mn = 55.
   - Molar gas constant = 8.314 J K^{-1} mol^{-1}.

1. You are provided with the following:

J: A solution made by dissolving 1.58 g of $KMnO_4$ in a distilled water to form a 0.5 dm^3 of an aqueous solution;

K: A solution made by dissolving 7.91 g of $Na_2S_2O_3.XH_2O$ in a distilled water to form 0.25 dm^3 of an aqueous solution;

L: A solution of 10% KI;

M: A starch solution;

N: A dilute H_2SO_4 solution.

Theory

A quantitative reaction between potassium permanganate, $KMnO_4$ and potassium iodide, KI can be represented by the reaction: $MnO_4^-(aq) + I^-(aq) \longrightarrow Mn^{2+}(aq) + I_2(aq)$.....(i)

The liberated iodine, I_2 is titrated against sodium thiosulphate, $Na_2S_2O_3$. The reaction taking place during this titration can be represented as follows:

$I_2(aq) + 2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + 2I^-$ .....(ii)

Procedure

(i) Pipette 20 or 25 cm^3 of **J** into a conical flask. Add an equal volume (20 cm^3 or 25 cm^3) of **L**, followed by another equal volume (20 cm^3 or 25 cm^3) of **N** in the same flask.

(ii) Titrate the mixture in (i) with **K**, until the colour change is observed. Add 2 cm^3 of **M** and continue titrating until a permanent colour change is observed.

(iii) Repeat the procedures (i) and (ii) three more times and record your results in a tabular form.

Summary

(i) The volume of the pipette used was _____.

(ii) _____ cm^3 of **J** liberated iodine that required _____ cm^3 of **K** for complete reaction.

Questions

(a) State the function of **M** in this experiment.

(b) State the main purpose of adding **L** into the conical flask containing an acidified **J**.

(c) Why is it advisable to add **M** just close to the end point in this experiment?

(d) Write an overall balanced reaction equation for the whole experiment.

(e) Calculate the;

(i) concentration of $KMnO_4$ in g/dm^3.

(ii) molarity of $KMnO_4$.

(iii) concentration of $Na_2S_2O_3.XH_2O$ in g/dm^3.

(iv) molarity of $Na_2S_2O_3$.
(v) concentration of $Na_2S_2O_3$ in g/dm^3.

(f) Find the value of X in $Na_2S_2O_3.XH_2O$.

2. You are provided with the following:

A: A solution of 0.02 M potassium permanganate;

C: A solution of 0.05 M oxalic acid in 0.5 M of sulphuric acid;

A thermometer (0°–100°C);

Stop watch/clock.

Theory

In an acidic medium, oxalic acid is oxidized by potassium permanganate. Completion of the reaction is indicated by the disappearance of the purple colour of the permanganate ions as shown by the following chemical equation:

$2MnO_4^-(aq) + 5C_2O_4^{2-}(aq) + 6H^+(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(l)$.

Procedure

(i) Put about 200 cm^3 of water into a 250 or 300 cm^3 beaker. Heat the beaker containing water. Use it as your water bath.

(ii) Measure 10 cm^3 of solution **A** and 10 cm^3 of **C**; put them into two separate boiling test tubes.

(iii) Take the test tubes containing **A** and **C** and put them into the water bath; allow the contents to warm to 50°C.

(iv) Pour both solutions **A** and **C** into a 50 cm^3 beaker. Immediately, start a stop watch/clock and record the time taken for the purple colour to disappear.

(v) Repeat the procedures (ii) to (iv) using temperatures 60°C, 70°C, 80°C and 90°C. Record your results as indicated in Table 1:

Table 1: Experimental Table

Temperature, T (°C)	Temperature, T (K)	Time for Reaction, t (Sec)	$\frac{1}{T}$ (K^{-1})	Log t (sec)
50				
60				
70				
80				
90				

Questions

(a) Write ionic redox half equations for this experiment.

(b) Plot a graph of log t (s) against $\frac{1}{T}(K^{-1})$.

(c) Calculate the activation energy (Ea) of the reaction for the experiment.

3. Sample **B** contains **two cations** and **one anion**. Perform the experiments given in Table 2 and record the observations and make appropriate inferences. Hence, identify the two cations and an anion.

Table 2: Experimental Table

S/n	Experiment	Observations	Inferences
(a)	Observe sample **B**.		
(b)	Heat a small portion of the sample in a dry test tube.		
(c)	Add concentrated sulphuric acid to a small portion of the sample.		
(d)	Perform a flame test.		
(e)	To a small portion of the sample solution, add NaOH solution.		
(f)	To a small portion of the sample solution, add dilute nitric acid followed by silver nitrate solution, then ammonia solution.		
(g)	To the small portion of the sample solution, pass hydrogen sulphide gas or ammonium sulphide solution in the presence of hydrochloric acid. Filter the precipitates to obtain filtrate and residue.		
	(i) To the filtrate add dilute acetic acid followed by a few drops of lead acetate.		
	(ii) Dissolve the residue, add aqua regia and then excess ammonia solution.		

Questions

(i) Write the molecular formula for the sample.

(ii) What are the cations and anion in the sample?

THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

ADVANCED CERTIFICATE OF SECONDARY EDUCATION

EXAMINATION

132/3C **CHEMISTRY 3C**

(ACTUAL PRACTICAL C)

(For Both School and Private candidates)

Time: 3:20 Hours **Year: 2023**

Instructions

1. This paper consists of **three (3)** questions**,** Answer **all** questions.
2. Question **one (1)** carries **20** marks, and the other **two(2)** carry **15** marks each.
3. Qualitative Analysis Guide (QAG) authorized by NECTA may be used.
4. Mathematical tables and non-programmable calculators may be used.
5. All writing must be in **blue** or **black** ink **except** drawing which must be in pencil
6. Cellular phones and any unauthorized materials are **not** allowed in the examination room.
7. Write your **Examination Number** on every page of your answer booklet (s).

The folowing information may be useful:

H=1, C=12, 0=16, S=32, Na=23, K=39, Mn=55

1. You are provide with the following:

   B1: A solution of H_2O_2 prepared by diluting 1.00 cm^3 with distilled water to form 250 cm^3 of an aqueous solution;

   B2: A solution of $KMnO_4$ made by dissolving 0.79 g in distilled water to form a 250 cm^3 of an aqueous solution.

   B3: A dilute H_2SO_4;

   Procedure

   (i) Pipette 20 or 25 cm^3 of **B1** into a conical flask. Add 10 cm^3 of **B3**.

   (ii) Titrate the mixture from step (i) against **B2** until a pink colour is observed.

   (iii) Repeat the procedures (i) and (ii) three more times and record your results in tabular form.

   Summary

   (i) The volume of pipette used was ____ cm^3.

   (ii) _____ cm^3 of solution **B1** required _____ cm^3 of **B2** for complete reaction.

   Questions

   (a) Write the two half reaction equations for the experiment.

   (b) Write a balanced ionic equation for the whole process.

   (c) Calculate the concentration of the original solution of hydrogen peroxide in g/dm^3 .

   (d) Calculate the volume of oxygen gas produced at s.t.p when **B1** reacted with an acidified **B2**

2. You are provided with the following:

   S: A solution of 0.5 M sodium thiosulphate;

   T: A solution of 0.1 M nitric acid; A stop watch/clock; A white plain paper marked N; A thermometer (0 – 100°C);

   Theory

   A yellow precipitate of amorphous Sulphur can be obtained by the action of the dilute acid on sodium thiosulphate ($Na_2S_2O_3$) according to the equation;

   $$\boldsymbol{S_2O_3^{2-}(aq) + 2H_3O^{+}(aq) \rightarrow 3H_2O(l) + S_2O(g) + S(s)}$$

   The precipitated Sulphur causes the solution to become opaque. From this phenomenon, you can assess the rate of Sulphur precipitation by measuring the time taken for the solution to become totally opaque due to Sulphur.

   Procedure

   (i) Place a 50 cm^3 beaker on top of a white plain paper marked **N** in such a way that, the mark is clearly seen through the bottom of the beaker.

   (ii) Put about $\frac{3}{4}$ full of water into a 250 or 300 cm^3 beaker and use it as your water bath.

   (iii) Measure 10 cm^3 of solution S and 10 cm^3 of **T** into two separate boiling test tubes.

   (iv) Put the two boiling test tubes containing S and T into the water bath and warm the contents to about 50°C.

   (v) Immediately pour the hot solutions of S and T into a 50 cm^3 beaker placed on top of letter N in step (i), and immediately start a stop watch/ clock.

   (vi) Using a glass rod, stir the reaction mixture in (v) and record the time taken in seconds, for letter N to disappear completely.

   (vii) Repeat the procedures (iii) to (vi) at temperatures 60°C, 70°C and 80°C and tabulate your results as indicated in Table 1:

Table 1: Experimental Table.

Temperature of the Reaction Mixture		Time for reaction, t (sec)	$\frac{1}{T}\left(K^{-1}\right)$	$\frac{1}{t}\left(Sec^{-1}\right)$	$\log\frac{1}{t}\left(Sec^{-1}\right)$
°C	T (K)				
50					
60					
70					
80					

Questions

(a) Plot a graph of $\log\frac{1}{t}\left(Sec^{-1}\right)$ against $\frac{1}{T}\left(K^{-1}\right)$.

(b) Determine the slope of the graph in part (a).

(c) Using the equation, $K = AEe^{\frac{-Ea}{RT}}$, which gives the relation describing the dependence of the rate constant on temperature, determine the value of activation energy in a given equation.

3. Sample **Z** contains two cations and one anion. Perform the experiments given in the Table 2 and record the observations. Make appropriate inferences and hence, identify the two cations and anion.

Table 2: Experimental Table

S/n	Experiment	Observations	Inferences
(a)	Observe sample **Z**.		
(b)	Heat small portion of the sample in a dry test tube.		
(c)	Perform a flame test.		
(d)	Add concentrated sulphuric acid to the dry sample.		
(e)	To the small portion of the prepared solution, add HCl followed by barium chloride solution.		
(f)	To the small portion of the prepared solution, add excess ammonia solution and then pass hydrogen sulphide gas slowly for one minute.		
(g)	Perform confirmatory tests for cations present in the sample		

Questions

(i) Write the molecular formulas for the samples.

(ii) What are the cations and anion in the sample?

THE UNITED REPUBLIC OF TANZANIA
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ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION 2023

132/3A **CHEMISTRY 3A**
ACTUAL PRACTICAL A
3 HOURS PRACTICAL ADVANCE INSTRUCTIONS

1.0 IMPORTANT

1.1 GREAT CARE MUST BE TAKEN **NOT** TO DIVULGE THESE INSTRUCTIONS TO BOTH CANDIDATES AND TO UNAUTHORIZED PERSONS EITHER DIRECTLY OR INDIRECTLY.

1.2 MAKE SURE THAT THE CANDIDATES ARE PROVIDED WITH CHEMICALS AND APPARATUSES AS INDICATED IN THESE 3 HOURS PRACTICAL ADVANCE INSTRUCTIONS ONLY AND **NOT** OTHERWISE.

2.0 PREPARATION AND LABELLING OF CHEMICALS AND APPARATUSES

2.1 Question 1

- Mix 4.8 g of sodium hydroxide and 6.36 g of anhydrous sodium carbonate. Dissolve the contents to make 1 dm^3 of solution and label it **T1**. Allow 150 cm^3 per candidate.
- Prepare 0.2 M hydrochloric acid and label it **T2**. Allow 125 cm^3 per candidate.
- Prepare phenolphthalein indicator and label it **POP**.
- Prepare methyl orange indicator and label it **MO**.
- Provide each candidate with 1 burette, 1 wire gauze, 1 white tile, 1 pipette (20 or 25 cm^3), 2 titration flasks, 1 retort stand with accessories.
- Provide each candidate with a pipette filler.

2.2 Question 2

- Dissolve 49.6 g of hydrated sodium thiosulphate, $Na_2S_2O_3.5H_2O$ in distilled water to make 1 dm^3 solution. Label it **P1** and allow 50 cm^3 per candidate.
- Prepare 0.1 M hydrochloric acid and label it **P2**. Allow 50 cm^3 per candidate.
- Provide 50 cm^3 distilled water per candidate and label it **distilled water**.
- Provide 1 stop watch per candidate.
- Provide each candidate with a 50 cm^3 beaker.
- Provide each candidate with a 10 cm^3 measuring cylinder.
- Provide a white plain paper uniformly marked **X** for each candidate.

2.3 Question 3

- Prepare a mixture of equal amount of iron (II) chloride ($FeCl_2$) and copper (II) chloride ($CuCl_2$) and label it **U**. Allow 4 g per candidate.
- Provide about 300 cm^3 distilled water per candidate.
- Provide a centrifuge to candidates in the ratio of 1:4 or provide each candidate with a filter paper and a funnel.
- Prepare hydrogen sulphide gas source for sharing in a maximum ratio of 1:4.
- Prepare aqua regia (3 parts concentrated HCl and 1 part HNO_3): Each candidate will require about 5 cm^3.
- Provide each candidate with 2 test tube holders.
- Provide each candidate with a piece of nichrome wire or platinum wire of about 15 cm in length).
- Provide sodium hydroxide, dilute hydrochloric acid, concentrated hydrochloric acid and sulphuric acid, potassium ferricyanide or potassium hexacyanoferrate(II), ammonia solution, dilute nitric acid and silver nitrate as bench reagents.
- Prepare heat source or burner for sharing in a maximum ratio of 1:4.