

**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: 2022

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 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:
 - Rydberg constant, $R_H = 1.09678 \times 10^7 \text{ m}^{-1}$
 - Gas constant, $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$ or $0.0821 \text{ atm mol}^{-1} \text{ K}^{-1} \text{ dm}^3$
 - Gram Molar Volume (GMV) = $22.4 \text{ dm}^3 = 22400 \text{ cm}^3$
 - Standard temperature = 273 K
 - Standard pressure = $760 \text{ mm Hg} = 1.0 \times 10^5 \text{ N m}^{-2} = 1 \text{ atm}$
 - Planck's constant, $h = 6.63 \times 10^{-34} \text{ J s}$
 - Velocity of light, $c = 3.0 \times 10^8 \text{ m/s}$
 - Mass of an electron = $9.11 \times 10^{-31} \text{ kg}$
 - Atomic masses: H = 1, C = 12, O = 16, S = 32



2

SECTION A (70 Marks)

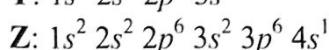
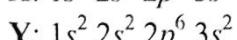
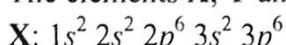
Answer all questions in this section.

1. (a) Energy of an electron in hydrogen atom is given by the expression

$$E_n = \frac{-1.312 \times 10^6}{n^2} \text{ J/mol.}$$

- (i) Calculate the amount of energy required to promote an electron from the first energy level to the third energy level.
(ii) Why an electron in its ground state possesses energy less than zero? **(03 marks)**

- (b) (i) The elements **X**, **Y** and **Z** have the following electronic configurations:



The first ionization energies of the three elements (not in the same order) are 420, 740, and 1500 kJ/mol and the atomic radii are 1.60, 0.94 and 1.97\AA . Identify the three elements and match the appropriate ionization energy and atomic radius to each configuration. **(03 marks)**

- (ii) Excited sodium atoms may emit radiation with the frequency of $5.09 \times 10^{14}/\text{s}$. What is the energy of the photons associated with this radiation? **(02 marks)**

- (c) Briefly, differentiate the following terms:

- (i) Line from continuous spectrum.
(ii) Absorption from emission spectrum. **(02 marks)**

2. (a) Consider the following reaction that takes place in a fixed volume of a container:

$\text{H}_2(\text{g}) + \text{Br}_2(\text{g}) \rightarrow 2\text{HBr}(\text{g})$ $\Delta H^\circ = -104 \text{ kJ/mol}$. How each of the changes affect the quantity of the reactants, products and equilibrium constant (K_C)? Answer by writing "Increase", "Decrease", or "No change" appropriately, in a tabular form:

Change	H_2	Br_2	HBr	K_C Value
Addition of some H_2				
Removal of some HBr				
Raise in temperature				
Increase in pressure				

(08 marks)

- (b) When the reaction $2\text{NO}(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{NOCl}(\text{g})$ was studied at 25°C , the partial pressures at equilibrium were found to be 1.2 atm for NOCl , 5.0×10^{-2} atm for NO and

0.3 atm for Cl. What would be the K_p value for this reaction at 25 °C?

(02 marks)

3. (a) If the vapour pressure of water at 20 °C is 17.5 mm Hg and lowering of vapour pressure of a sugar solution is 0.061 mm Hg, calculate;

- (i) The relative lowering of vapour pressure.
(ii) The vapour pressure of the solution.
(iii) The mole fraction of sugar and water.

(04 marks)

- (b) Ethanoic acid had a freezing point of 16.63 °C. When 2.5 g of an organic solute was added to 40 g of the acid, the freezing point was lowered to 14.48 °C. Calculate the relative molecular mass of the solute (Given K_f for ethanoic acid = 3.9 °C/m). (03 marks)

- (c) An aqueous solution freezes at 272.07 K while pure water freezes at 273 K. Calculate the molality and boiling point of this solution (Given K_f for water = 1.86 K/m, K_b = 0.512 K/m). (03 marks)

4. (a) (i) Predict whether a chemical bond will be covalent or ionic basing on the charge and the relative size of the cations and anions as follows:

Cation/anion	Ionic radius (nm)	Chemical bond
C^{4+}	0.015	
I^-	0.216	
Na^+	0.095	
F^-	0.136	

- (ii) "Intermolecular hydrogen bonding and dative covalent bonding are among the types of bonds exhibited by a number of molecules." Justify this statement by drawing a structure of a molecule for each type of the bonds aforementioned.

(04 marks)

- (b) Briefly, comment on the following observations:

- (i) Fluorine, chlorine and bromine form hydrides, but the hydride of fluorine forms hydrogen bond, whereas those of chlorine and bromine do not.

- (ii) When molecules of hydrogen chloride are placed together, they do not show induced dipole interactions but they do so when placed with molecules of argon.

(02 marks)

- (c) (i) What is the difference between sp^2 and sp hybridization?

- (ii) Which bond is stronger than the other in each of the following pairs? Give a reason for your choice.

$\text{C}\equiv\text{O}$ or $\text{C}=\text{O}$; $\text{C}-\text{N}$ or $\text{C}-\text{O}$; $\text{C}-\text{C}$ or $\text{C}=\text{C}$

(04 marks)

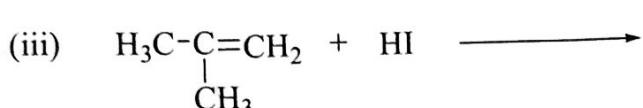
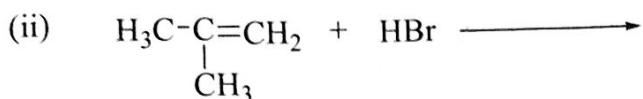
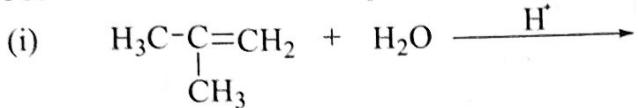
5. (a) A certain chemical industry in Tanzania got an order to supply some reagents for research purposes. However, the requested reagents were not in the stock at that moment though enough starting materials shown in each case were present. What synthetic route(s) will you devise in each case to meet the order required? Confine your reactions in not more than four steps.

- (i) Propan – 1, 2-diol from propene
(ii) Acetone from 2-methyl propene

- (iii) Ethanol from propane
 (iv) Ethyne from calcium carbide

(05 marks)

- (b) Use Markovnikov's rule to predict the products of the following reactions:

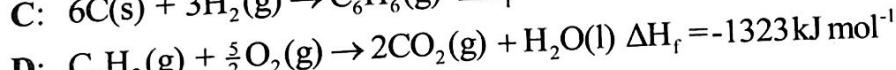
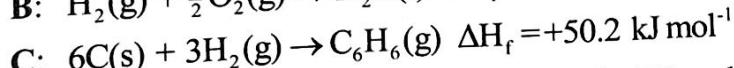
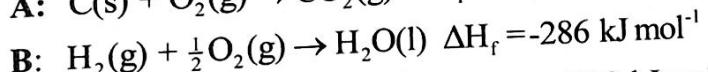
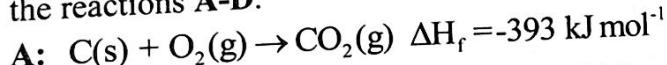


(03 marks)

- (c) "Wurtz synthesis is not suitable for preparation of an asymmetrical alkane." Briefly, justify this statement while supporting your answer with a chemical equation. **(02 marks)**

6. (a) (i) Given that, the heat of formation of $\text{CO}_2(\text{g})$, $\text{CO}(\text{g})$ and $\text{H}_2\text{O}(\text{g})$ are -393.5 , -121.31 and -241.8 kJ/mol, respectively. Calculate the enthalpy change (ΔH°) for the reaction $\text{CO}_2(\text{g}) + \text{H}_2(\text{g}) \longrightarrow \text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g})$. **(04 marks)**
 (ii) What are the four factors affecting the quantity of heat evolved or absorbed during a physical or chemical transformation? **(02 marks)**

- (b) Determine the heat of formation of ethyne basing on the following information given by the reactions A-D.



(04 marks)

7. (a) Suppose you are employed by the National Environment Management Council (NEMC), an institution which has a mandate to oversee the environmental management issue in Tanzania; What are the four possible intervention measures of environmental degradation you can address to the community. **(04 marks)**

- (b) "Most of the greenhouse gases are produced from anthropogenic activities." Justify this statement by giving two reasons while supporting your answer with appropriate chemical equation in each case. **(02 marks)**

- (c) Acid rain is formed as a result of excessive dissolution of gases in the atmosphere to produce acids with pH less than 5.6. What are the four chemical reactions that take place during the formation of an acidic rain? **(04 marks)**

SECTION B (30 Marks)

Answer two (2) questions from this section.

8. (a) (i) While pumping air into a ball, the volume as well as the pressure increase. Does the Boyles's law applicable here? Briefly, explain.
(ii) Hot air balloons are being used in the Serengeti National Park by tourists. Why hot air is more preferred in filling these balloons than cold air? Briefly, explain.
(iii) It is said that "Dalton's law of partial pressure cannot hold true for a mixture of SO_2 and O_2 gases. Briefly, explain the truth of this argument.
(iv) What would have happened to the gas pressure if the molecular collisions were not elastic? (04 marks)
- (b) The density of a gas at 27°C and 1520 mmHg pressure was found to be $5.46 \times 10^{-3} \text{ g/cm}^3$. What will be its density in g/dm^3 at s.t.p.? (04 marks)
- (c) (i) Relative densities of carbon dioxide and oxygen are 22 and 16, respectively. If 25 cm^3 of carbon dioxide diffuses in 75 seconds, what volume of oxygen gas will diffuse in 96 seconds under similar conditions? (05 marks)
(ii) What are the two significances of Graham's law of diffusion in our daily life? (02 marks)
9. (a) Briefly, explain five uses of metal oxides in daily life. (05 marks)
- (b) When a dilute nitric acid was added to a green solid P, a blue solution Q was formed and a gas R that formed a white precipitate with lime water was evolved. When the blue solution was evaporated to dryness by heating it in a crucible, a black solid S, brown fumes of gas T and a gas that relighted a glowing splint were formed.
(i) Identify solids P and S, and gases R and T.
(ii) Write an equation for the reaction between solid P and dilute nitric acid. (06 marks)
- (c) What is the importance of the following metal compounds in everyday life?
(i) Lime stone
(ii) Plaster of Paris (04 marks)
10. (a) Briefly explain the following concepts:
(i) Concentrated sulphuric acid is necessary for nitration of benzene.
(ii) Bromination of benzene takes place in the presence of Lewis acid, while that of hydroxybenzene does not require the presence of Lewis acid.
(iii) Despite chlorine atom being an electron withdrawing group, it directs an incoming group to the ortho or para positions in electrophilic aromatic substitution reactions. (03 marks)
- (b) During one of the practical sessions in a school, a student wanted to differentiate a set of reagents. Briefly, advise the student on how to differentiate the given sets of reagents while supporting your answer with a chemical equation:
(i) Benzene and ethane

- (ii) 3-chloro-2-methylpent-2-ene and 1-chloropropane (06 marks)
- (iii) Bromobenzene and bromomethane
- (c) Briefly explain the following concepts:
- (i) $(CH_3)_2CHBr$ undergoes SN_1 mechanism, while $CH_3CH_2CH_2Br$ undergoes SN_2 mechanism when they react with aqueous alkalis.
- (ii) Haloalkanes undergo nucleophilic substitution reactions, while halobenzenes undergo electrophilic substitution reactions. (04 marks)
- (d) Two isomeric hydrocarbons **K** and **L** have the molecular formula C_9H_{12} . On oxidation, **K** gives a monocarboxylic acid which when heated with excess soda lime yields benzene. When **L** is oxidized, it gives tricarboxylic acid, which can undergo nitration to give a mono-derivative. What are the structural formulae of **K** and **L**? (02 marks)

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ADVANCED CERTIFICATE OF SECONDARY EDUCATION
EXAMINATION

132/3A

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

Time: 3:20 Hours

Year: 2022

Instructions

1. This paper consists of **three (3)** questions. Answer **all** questions.
2. Question number **one (1)** carries 20 marks and the other **two (2)** carry 15 marks each.
3. Qualitative Analysis Guide (QAG) sheet authorized by NECTA may be used.
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. You may use the following atomic masses: H = 1, C = 12, O = 16, Cl = 35.5, Na = 23.



1. You are provided with the following solutions:
- A: 2.96 g of a mixture of sodium carbonate and sodium bicarbonate in a 500 cm³ of an aqueous solution;
- B: 1.46 g of a pure hydrochloric acid in a 0.4 dm³ of an aqueous solution;
- MO: Methyl orange indicator;
- POP: Phenolphthalein indicator.

Procedure

- (i) Pipette 20 or 25 cm³ of A into a 250 cm³ titration flask.
- (ii) Add two drops of POP.
- (iii) Titrate this solution against B until a colour change is observed.
- (iv) Record the first titre value.
- (v) Add MO to the same solution.
- (vi) Continue titrating until a second colour change is observed.
- (vii) Record the second titre value.
- (viii) Repeat the titration procedures (i) to (vii) three times and record your results in a tabular form.

Summary

_____ cm³ of solution A required _____ cm³ of solution B when POP was used and _____ cm³ of solution B when MO was used.

Questions

- (a) Based on the indicators used, state the colour changes during the titrations.
 - (b) Calculate the concentration of solution A in moles per litre when;
 - (i) POP was used.
 - (ii) MO was used.
 - (c) Calculate the percentage of sodium carbonate in solution A.
2. You are provided with the following:
- K1: 0.1 M sodium hydroxide;
- K2: Butanedioic acid of unknown concentration;
- K3: Isobutyl alcohol;
- POP: Phenolphthalein indicator;
- Distilled water.

Theory

Butanedioic acid (CH_2COOH)₂ dissolves in both water and isobutyl alcohol at a constant ratio of concentration and temperature.

Procedure 1

- (i) Pipette 20 or 25 cm³ of K2 into a conical flask. Add 2 or 3 drops of POP.
- (ii) Put K1 in a burette.
- (iii) Titrate K2 against K1 in the presence of POP until a colour change is observed.
- (iv) Record the volume of the pipette and the volume of K1 used as well as the room temperature.

Procedure 2

- (i) Put 50 cm³ of K3 into a separating funnel. Add to it 50 cm³ of distilled water.
- (ii) Measure 50 cm³ of K2 and put it into a separating funnel in (i). Shake the mixture well.
- (iii) Run off the lower aqueous layer into a clean beaker.
- (iv) Using a measuring cylinder, measure 25 cm³ of the aqueous layer into a clean conical flask.
- (v) Titrate this aliquot against K1 using POP (only one titration is enough).

Summary 2

Volume of K1 used was _____.

Questions

- (a) Write a balanced chemical equation representing the reaction taking place in the titration.
- (b) Calculate the;
 - (i) initial concentration of K2 in water.
 - (ii) final concentration of K2 in the aqueous layer.
 - (iii) acid concentration in the organic layer.
 - (iv) partition coefficient of K2 between water and isobutyl alcohol.
3. Substance H contains **two cations** and **one anion**. Use the information given in the experiments column of the experimental Table to complete the observations and inferences columns. Hence, identify the two cations and an anion in H.

Experimental Table

S/n	Experiments	Observations	Inferences
(a)	Appearance of the sample H.		
(b)	Heat a small portion of the sample in a dry test tube.		
(c)	Perform a flame test.		
(d)	Add concentrated sulphuric acid to the small portion of the sample.		
(e)	To the small portion of the prepared solution, add dilute sodium hydroxide.		
(f)	To the small portion of the solution, 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 ferrocyanide (III).		
	(ii) Dissolve the residue in aqua regia and then add excess 50% ammonia solution.		
(g)	To the small portion of the solution, 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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EXAMINATION

CHEMISTRY 3B

(ACTUAL PRACTICAL B)

(For Both School and Private candidates)

Time: 3:20 Hours

Year: 2022

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 following information may be useful:

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



1. You are provided with the following:

AA: A solution of sodium oxalate, $\text{Na}_2\text{C}_2\text{O}_4$ made by dissolving 3.35 g of the salt in a 0.5 dm^3 solution;

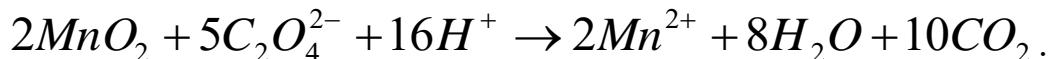
BB: A solution of potassium permanganate, KMnO_4 ;

CC: A solution of hydrated iron(II) ammonium sulphate, $\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot \text{XH}_2\text{O}$. made by dissolving 33.3 g of the salt in distilled water to form 1 dm^3 of an aqueous solution;

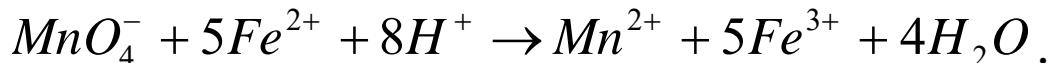
DD: Dilute sulphuric acid; Thermometer.

Theory

Standardization of **BB** solution is done by titrating it against the standard solution of **AA** in an acidic medium. The resulting reaction equation is as follows:



The standardized is then titrated against **CC** whose number of molecules of water of crystallization can then be calculated. The resulting equation is as follows:



Procedure:

Part I

- (i) Measure 10 cm^3 of solution **AA** into a titration flask and then add 10 cm^3 of solution **DD**.
- (ii) Heat the contents near boiling (about 80°C)
- (iii) (Titrate this hot mixture against solution **BB** from the burette until there is a colour change.)
- (iv) Repeat the steps (i) to (iii) to obtain three more readings and record the results in a tabular form.

Summary

_____ cm³ of solution **AA** required _____ cm³ of solution **BB** for a complete reaction.

Part II

- (i) Measure 10 cm³ of solution **CC** into a titration flask and then add 10 cm³ of solution **DD**.
- (ii) Titrate the reaction mixture against solution **BB** from the burette until there is a colour change.
- (iii) Repeat the steps (i) and (ii) to obtain three more readings and record the titration results in a tabular form.

Questions

- (a) Calculate the;
 - (i) molarity of potassium permanganate.
 - (ii) concentration of potassium permanganate in gdm⁻³.
 - (iii) molarity of iron(II) salt.
 - (iv) concentration of anhydrous iron(II) salt in gdm⁻³.
- (b) Find the value of **X** in the formula FeSO₄(NH₄)₂ SO. XH₂O₄.

2. You are provided with the following:

JJ: 0.05 M sulphuric acid;

MM: 0.035 M potassium iodide;

KK: 0.035 M sodium thiosulphate;

LL: 0.9 M hydrogen peroxide;

HH: Starch solution; Stop watch.

Theory

Hydrogen peroxide reacts with iodide ions in the presence of hydrogen ions in an aqueous solution as follows: $H_2O_2 + 2I^- + 2H^+ \rightarrow 2H_2O + I_2$. The iodine produced immediately reacts with thiosulphate ions as follows:

$I_2 + 2S_2O_3^{2-} + 2I^- + S_4O_6^{2-}$. When all the thiosulphate ions have reacted, iodine begins to accumulate in the solution and its presence can be detected by starch.

Procedure

- (i) Using a measuring cylinder, put 100 cm³ of solution JJ into a conical flask and then 10 cm³ of solution MM into the same flask, followed by 10 cm³ of solution HH.
- (ii) Swirl the contents of the flask to ensure proper mixing.
- (iii) Fill the burette with the solution KK and adjust the level to zero mark. Run 2.0 cm³ of the solution KK into the mixture and again swirl the contents.
- (iv) Using a measuring cylinder, add 10 cm³ of solution LL into the mixture and immediately start the stop watch. Shake well the flask when the solution LL is running into it.
- (v) Note the time when suddenly the mixture turns blue. Without stopping the stop watch, add further 2.0 cm³ of solution KK and shake well the flask. Again note the time when the blue colour reappear.
- (vi) Continue this way until you have added 12 cm³ of the solution KK.

- (vii) Record all your readings as indicated in Table 1.
- (viii) Repeat procedure (i) to (vii) using fresh portions of the solutions, but this time use 10 cm³ of diluted solution LL. Dilute solution LL as follows; measure 10 cm³ of solution LL into a beaker and then add 10 cm³ of distilled water. Swirl the contents

Results

Table 1: Undiluted LL

Volume of KK added (cm ³)	2	4	6	8	10	12
Time in seconds						

Table 2: Diluted LL

Volume of KK added (cm ³)	2	4	6	8	10	12
Time in seconds						

Questions

- On the same axes, plot a graph showing the volume of sodium thiosulphate solution, KK against time for each experiment.
- Comment on the shapes of your graphs and explain what is expected to the graph if you continue adding KK for a longer period of time.
- Calculate the slope of each curve and deduce the order of the reaction with respect to hydrogen peroxide.
- How is the amount of iodine liberated related to the amount of hydrogen peroxide consumed?

3. Substance T contains two cations and one anion. Use the information given in the experiments column of the Table 3 to complete the observations and inferences columns. Hence, identify the two cations and an anion.

Table 3

S/N	Experiments	Observations	Inferences
(a)	Appearance of the sample.		
(b)	Heat a small portion of the sample in a dry test tube.		
(c)	Add concentrated sulphuric acid to the small portion of the sample.		
(d)	Perform a flame test.		
(e)	To a small portion of a sample solution, add sodium hydroxide solution.		
(f)	To a small portion of a sample solution add nitric acid followed by silver nitrate solution, then aqueous ammonia.		
(g)	To the small portion of the solution, pass hydrogen sulphide gas or ammonium sulphide solution in presence of hydrochloric acid. Filter the precipitates to obtain filtrate and residue.		
	(i) To the filtrate, add bariumchloride solution.		
	(ii) Dissolve the residue, add aqua regia and then excess 50% ammonia solution.		

Questions

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

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EXAMINATION

CHEMISTRY 3C

(ACTUAL PRACTICAL C)

(For Both School and Private candidates)

Time: 3:20 Hours

Year: 2022

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 following information may be useful:

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



1. You are provided with the following:

K: A solution of 7.45 g of an impure hydrated sodium carbonate in a 500 cm³ of an aqueous solution;

L: 1.825 g of hydrochloric acid in a 500 cm³ of an aqueous solution.

POP: Phenolphthalein indicator;

MO: Methyl orange indicator.

Procedure

- (i) Pipette 20 or 25 cm³ of a solution **K** and put it in a clean conical flask.
- (ii) Add two drops of **POP**.
- (iii) Put solution **L** into the burette.
- (iv) Titrate solution **L** against **K** using **POP** until the colour change is observed.
- (v) Add two drops of **MO** and continue to titrate until further colour change is observed.
- (vi) Repeat the procedures (i) - (v) three times and record the results in a tabular form.

Questions

(a) Calculate the average titre value when:

- (i) **POP** was used.
- (ii) **MO** was used.

(b) Write a balanced chemical equation when;

- (i) **POP** was used.
- (ii) **MO** was used

(c) Calculate the total overall average volume of the solution **L** used for complete reaction with the solution **K**.

(d) Write the overall reaction equation of the **L** and **K**.

- (e) Calculate the percentage purity of the hydrated sodium carbonate.
2. You are provided with the following:

M: A solution of 0.05 M sodium thiosulphate;

N: A solution of 0.1 M nitric acid;

Stop watch;

Thermometer.

Theory

Dilute nitric acid reacts with sodium thiosulphate to form a white precipitate of sulphur according to the following equation:

$S_2O_3^{2-}_{(aq)} + 2H_3O^+_{(l)} \rightarrow 3H_2O_{(l)} + SO_{2(g)} + S^-_{(s)}$. The precipitate of sulphur causes the solution to become opaque. From this phenomenon, the rate of formation of sulphur precipitate can be measured

Procedure

- (i) Draw a letter **X** on a sheet of white paper and place a 100 cm³ beaker on top of the letter.
- (ii) Pour about 200 cm³ of a clean water into a 250 or 300 cm³ beaker and heat gently. Use this as your water bath.
- (iii) Measure exactly 10 cm³ of **M** and 10 cm³ of **N** into separate two boiling tubes. Put the two tubes in the water bath and warm the contents to about 50 °C.
- (iv) Immediately, pour the hot solutions **M** and **N** into a 100 cm³ beaker in (i) and simultaneously start the stop watch.
- (v) Swirl the mixture in (iv) and record the time taken for the letter X to disappear completely.
- (vi) Repeat the steps (i) - (v) using temperature 60°C, 70°C and 80°C.
- (vii) Record your results in a tabular form.

Questions

- (a) Plot a graph of $\log \frac{1}{t} (\text{sec}^{-1})$ against $\frac{1}{T} (\text{K}^{-1})$.
- (b) Determine the slope of the graph.
- (c) Using Arrhenius equation, determine the activation energy of the reaction.
3. Substance H contains two cations and one anion. Use the information given in the experiments column of the experimental Table to complete the observations and inferences columns. Hence, identify the two cations and an anion.

S/n	Experiments	Observations	Inferences
(a)	Appearance of the sample.		
(b)	Heat a 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 dilute HCl followed by barium chloride solution.		
(f)	To the small portion of the prepared solution, add excess ammonia solution and then add ammonia sulphide solution or pass hydrogen sulphide slowly for one minute.		
(g)	Perform confirmatory test for cations present in the sample.		

Questions

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