PRINCIPAL EXAMINER'S REPORT

BOTSWANA EXAMINATIONS COUNCIL

BGCSE CHEMISTRY

2023

Advancing learning, certifying your future

GENERAL OVERVIEW

1 Candidates were able to show knowledge and understanding of mathematical skills in chemical calculations which required analysis. Therefore, Centres are commended for imparting such skills to the candidates. However, candidates showed lack of understanding in writing chemical equations. Most candidates failed to write the correct formulae of substances as well as balancing of equations. Candidates also showed lack of knowledge when dealing with reactions involving conditions and as such wrote conditions as part of the reacting species. Hence, Centres are encouraged to give more practice to the candidates concerning chemical formulas and equations.

2 Candidates were able to; make conversions from given quantities, give answers to the correct number of significant figures and make appropriate calculations. However, the quality of presentation of answers in questions which required application of concepts and making explanations using the relevant concepts was low. This was evident in question 1(b)(ii), 3(a)(v) and 6(c)(iv) where candidates failed to give reasons.

3 There was a notable improvement in the quality of diagrams, graphs and structures although some candidates showed lack of understanding of structural isomerism and choosing an appropriate scale for a graph. Centres are advised to emphasise more on the correct arrangement of atoms in organic compounds. A significant improvement was noted in the correct presentation of electrons in dot and cross diagrams even though some candidates did not show all electrons. There was an improvement in observing mark allocation when answering questions and centers are applauded for the good work.

4 Concerning practical paper, all centres are still encouraged to perform both experiments in paper 4 and send their reports. This helps the examiners to mark the candidates according to the results obtained by their supervisors. Centres that did the experiments and send the supervisors values are commended. Those centres that provided the report, answered all questions on the question paper, make the marking easy and also help their candidates because the candidates would not be penalised unnecessary.

5 The centres are commended for taking note of the previous year's comments on some problems associated with scientific reporting and the use of a calculator. Centres did report the supervisors value clearly, this was a good improvement from the previous years. This year's cohort used the calculator very well and reported their titres to 1 decimal point. Only a few candidates reported titres to 2 decimal places. Candidates must be encouraged to continue using values on their calculators rather than to round of the values. This practise helps candidates to use the most accurate value during calculations and also be able to score marks on the subsequent questions not by error carried forward. Working must also be shown. There was an improvement from the previous cohort especially on titration. Question 1 (quantitative analysis, titration) was well done compared to question 2 (qualitative analysis). Reporting on solubility of precipitates was still a challenge for some centres.

6 The quality of answers in almost all centres for the 2023 cohort was very satisfactory on significant figures. Centres are still encouraged to emphasize on significant figures and also to give more practises on significant figures because in quantitative analysis (question 1, titration) accuracy is very important.

7 The cohort, just like in previous years, failed to score maximum points on high order questions for example 1d, 2b(ii), 2d(ii), 2c(ii), 2d and 2e(ii). Centres are encouraged to give more practises on questions such as calculation from stock solution, in order to give the candidates, the skills on how to solve such problems. Centres are also encouraged to emphasis testing and **identify any gas produced**, for instance at 2b(iii).

Centres are advised to continue encouraging the candidates to answer questions at the space given under each and every question. Candidates this year unlike the previous year, did match the observation they made with the test they did. Centres should explain to candidates why excess alkaline solution is added, [be it for solubility or and amphoteric]. Candidates must be encouraged to follow instructions on the question paper especial, “you should test and identify any gas produced”, at question 2.

Multiple-Choice: 0570/01

Section 1: General Comments

This paper was well attempted by most of the candidates with a mean of 27.12. The reliability of the component has remain unchanged as compared to the previous year. One question has a proportion correct of equal to or less than 10%, meaning that less than 10% of the candidates managed to score in this item compared to two in 2022 cycle. While five questions seemed to be much easier as equal to or more than 90% of the candidates got them correct compared to four the previous year.

Section 2: Comments on Individual Questions

Item 1: The question was well done as about 90% of the candidates managed to deduce that the number of neutrons remain unchanged in an ion. Only about 5% of the candidates showed that neutrons of an ion do change, in this case they chose option A.

Item 2: This question was fairly answered. The average number of the cohort were able to come up with the formula of the hydroxide of element **X**, deduced from the formula of the nitride of element **X**, **X**N. The most competing distractor is option A, where the 36% of the cohort just assumed that the valency of element **X** is 1, hence, XOH formula was derived.

Item 3: The question was poorly answered as about 30% of the cohort managed to choose a laboratory apparatus that can be used to prepare a standard solution. Distractor C got the highest bid as most of the candidates choose an apparatus used during titrating, followed by distractor B, which is test-tube. Therefore, Centres are urged to give more practice to their candidates in preparing stork solution rather than the candidates finding the stork solution being prepared to them.

Item 4: Poorly done question. About 37% of the candidates were able to deduce the substances produced when silver oxide decomposes. Most of the candidates could not relate this question with the reactivity series of metals, as the oxides of reactive metals do not decompose to oxygen has and metal. Therefore, centres are encouraged to emphasise on this topic as it has been a norm where candidates fail to predict the correct products on the decomposition of oxides of more reactive metals and less reactive metals. Distractors C and D became more competitive to the answer as they received 26% and 27% respectively.

Item 5: Well answered question. The majority of the candidates, 79%, were able to deduce the monomers of the macromolecule given. This is recommendable to the centres as it showed that most candidates were imparted on the skill of breaking a macromolecule into its monomers.

Item 6: This question was averagely done as 51% of the candidates managed to choose a metal that is extracted using carbon. Again, like in question 4, the candidates failed to apply the reactivity series. Any metal which is above carbon in the reactivity series cannot be extracted using carbon, no displacement shall occur.

Item 7: The question was averagely attempted. About 55% of the candidates were able to determine the volume required to dilute 300 cm^3 of 0.20 mol / dm^3 into a 0.15 mol / dm^3 solution. The most competing distractor is option B.

Item 8: Fairly done as about 69% of the cohort managed to choose the method of producing clean dry chlorine gas.

Item 9: Poorly done question as about 30% of the candidates were able to recall and choose a metal that is not a constituent of duralumin alloy. Most of the candidates went for distractor D, about 35%, instead of C. Distractor B was also more competitive as about 27% of the cohort went for it.

Item 10: Fairly attempted as 55% of the cohort were able to identify a compound formed when propanol is reacted with acidified potassium dichromate(VI). About 27% of the candidates went for distractor D.

Item 11: Well answered. The majority of the candidates, about 88%, were able to recall a substance used to as a catalyst during the production of sulphur trioxide.

Item 12: Fairly done. About 59% of the candidates were able to recall soluble salts. All the distractors attracted almost similar magnitude.

Item 13: Well done. About 93% of the candidates seem to be much conversant with the Periodic Table.

Item 14: Well done. About 80% of the cohort could recall a property common to all covalent compounds.

Item 15: Fairly answered. Majority of the candidates, 79%, were able to identify the two organic compounds as isomers. Hence, centres are commended for imparting the skill of breaking macromolecules into their respective isomers.

Item 16: The question was well attempted as 81% of the cohort was able to recall the substances that are required for the extraction of iron from its ore.

Item 17: Fairly done. About 33% of the candidates could not identify the substance which does not remove the hardness caused by the presence of calcium sulphate in water,

Item 18: Fairly done as the majority of the candidates (about 79%) were able to interpret an energy diagram as that for option C. The candidates could choose the correct example of an endothermic reaction.

Item 19: Poorly done as the majority of the cohort (66%) could not recall the substances produced from the hydrolysis of fats in an alkaline medium. Among the candidates who got this question wrong 41% went for option A, which is the normal hydrolysis of fats in acidic medium. Therefore, centres are encouraged to emphasise the difference on the hydrolysis of fats in different mediums to their candidates.

Item 20: Fairly done. From this equation, $CO + Pb^{2+} + H_2O \rightarrow CO_2 + Pb + 2H^+$, candidates were asked to identify a reducing agent. But only 63% of the cohort managed to do such, while the rest went mostly for distractors B and D.

Item 21: Well done. About 87% of the candidates were all to identify the gas which is a bleaching agent, dissolves in water to form acidic solution and also being a reducing agent.

Item 22: Averagely done. About 50% of the cohort proved to be conversant with the correct ratios of volumes of gases produced during the electrolysis of dilute sulphuric acid. Distractors A and D took the largest share of the candidates who failed to determine the correct ratio of gases. Distractor B was chosen by only 3% of the cohort.

Item 23: Well attempted as 98% of the candidates were able to identify an element which is unreactive.

Item 24: Well done. The candidates seem to be much conversant in calculating the bond energies given bond energies. Hence, centres are commended for having given their candidates such skill.

Item 25: Averagely answered. Out of the 41% of the candidates who did not score in this item, the majority of them went for option D, followed by distractor B.

Item 26: Fairly done. About 38% of the candidates failed to deduce the structure of a non-biodegradable macromolecule. Among this group the equally went for distractors C and D.

Item 27: Fairly attempted. Most of the candidates (62%) were able to calculate the empirical formula of the hydrocarbon.

Item 28: Well done. Majority of the candidates (86%) were able to determine element Y, when given the formula of the oxide and its relative molecular mass. Centres are commended for imparting such a skill to their candidates.

Item 29: The question was fairly answered as about 68% of the candidates were able to recall the type of oxide carbon monoxide is. A good portion of the cohort (19%) went for distractor A, which is acidic and they confused it with carbon dioxide.

Item 30: Averagely answered. About 25% of the candidates went for distractor B instead of option C. Centres are advised to help their candidates to deal with all chemical reactions and observations that could be made during the electrolysis of concentrated hydrochloric acid using carbon electrodes.

Item 31: Poorly done. The cohort seemed to be short sighted when using the Avogadro's number as only 46% of the cohort managed to calculate the number of molecules in 2.48 g of chlorine. The most competing distractor is B, where the mass of chlorine was multiplied by 2 (number of atoms in a molecule) and the Avogadro's number. Centres are advised to emphasise more on this concept.

Item 32: Well done. About 84% of the candidates were able to identify the gases produced during the complete combustion of petrol.

Item 33: Well answered as 93% of the candidates managed to identify the functional group of alkane.

Item 34: Fairly done. A high order question which only the more prepared candidates could score. About 71% in the cohort could be able to determine the mass of $CoCl_2$ obtained after intensively heating $CoCl_2.6H_2O$. A handful of the cohort (17%) believed that all the $CoCl_2.6H_2O$ will disappear as they went for distractor A.

Item 35: Well done. About 81% in the cohort could identify a factor that would have no effect in the rate of reaction when copper(II) sulphate reacts with dilute sulphuric acid. Centres are commended for equipping their candidates on the factors that affect the rate of reaction and on reaction of bases and acids.

Item 36: Fairly done. The majority of the candidates (68%) were able to recall the test of an aluminium ion. Most of them who did not get the answer right went for distractor B, indicating a confusion between the test of aluminium and calcium. Centres should give more practice to their candidates concerning this concepts.

Item 37: Poorly answered. About 56% in the cohort could not see the acidic properties of the organic compound given, hence, failing to choose the right option. The question was all about acid and base reaction.

Item 38: Fairly attempted. About 74% in the cohort were able to calculate the mass of hydrogen in ammonium phosphate and this is commendable as the candidates were equipped with skill of converting mass to moles and then moles to mass again.

Item 39: Well done. About 81% in the cohort were able to recall a product formed when a base is reacted with ammonium salts. That's commendable to the centres.

Item 40: Well answered. The question was on a creating a simple cell, and most of the candidates (81%) were able to identify a workable simple cell.

Marking Key

1	C	**2**	C	**3**	D	**4**	A	**5**	B
6	C	**7**	A	**8**	B	**9**	C	**10**	B
11	D	**12**	C	**13**	B	**14**	C	**15**	C
16	D	**17**	B	**18**	C	**19**	B	**20**	A
21	C	**22**	C	**23**	A	**24**	C	**25**	C
26	B	**27**	C	**28**	D	**29**	D	**30**	C
31	A	**32**	A	**33**	B	**34**	B	**35**	B
36	A	**37**	B	**38**	D	**39**	A	**40**	D

PAPER 3

Generally the paper was fairly done by most candidates. Candidates showed lack of understanding in writing chemical equations. Most candidates failed to write the correct formulae of substances as well as balancing of equations. Candidates also showed lack of knowledge when dealing with interpretation of state symbols and as such failed to relate observations given reaction equations. Candidates also lacked skill for drawing conclusions from a graph.

Candidates were able to show knowledge and understanding of mathematical skills involved in chemical calculations. Candidates were able to; make conversions from given quantities, give answers to the correct number of significant figures and make appropriate calculations. There was a slight improvement in the quality of presentation of answers in questions which required application of concepts and making explanations using the relevant concepts.

There was a notable improvement in the quality of graphs and structures although some candidates showed lack of understanding of addition polymerisation and choosing an appropriate scale for a graph. Centres are advised to emphasise more on the correct arrangement of atoms in organic compounds and when drawing dot and cross diagrams. However, there was a significant improvement noted in the correct presentation of electrons in dot and cross diagrams.

COMMENTS ON INVIDUAL QUESTIONS

1. This question required candidates to recall and show understanding of properties and uses of the different substances provided in the list. The question also required candidates to show knowledge and understanding of Periodic Table as well as the structure of the atom. Some candidates lost marks for wrong spelling and the use of formulae.

(a) This part question was about a substance which has allotropes. It was done well by most candidates giving carbon as a correct response.

(b) This part question dealing with the extraction of iron from its compounds was done well by most candidates identifying that carbon is used.

(c) This part question was fairly done. Candidates were required to apply understanding of test for sulphates using acidified barium nitrate and identity sulphuric acid as a substance that will form the white precipitate. Some candidates lost marks for giving responses such as zinc and chlorine which will not give a white precipitate with barium nitrate. Centres are advised to emphasise and explain the observations made in the different tests question dealt with formation of hard water and the removal of hardness from water. The question was generally done well except that most of the candidates failed to show the skill of writing equations.

(d) This part question dealt with the structure of atoms, formation of ions and understanding of the Periodic Table. Most candidates were able to identify bromine as the correct response except the few who lost marks for failing to recognise that the ion should have an electronic configuration of 2,8,8 hence gave responses such as zinc and copper which did not score.

(e) Candidates were expected show knowledge of properties of group seven elements and recognise that bromine is a red brown liquid.

2. This question dealt with analysis of a sample of milk. Candidates were required to handle information and apply problem solving skills involving analysis. The question was fairly done by most candidates. Candidates showed lack of skills for writing correct formulae.

(a) This part question was fairly done by the candidates.

i This part question was fairly done. Candidates were required to identify an ion with the highest concentration from the table and some candidates were able to recognise potassium as a correct answer but some candidates failed to realise that the higher the mass per $100cm^3$ the higher the concentration and gave responses such as Calcium and chloride.

ii This question was fairly done as candidates were able to calculate the mass of Ca^{2+} ions in $20cm^3$ of the sample as 25mg. Some candidates despite being able to calculate the mass correctly, lost marks for quoting the wrong units, while on the other hand others failed to recognise that they have to use $20cm^3$ and hence gave 125mg as the answer. Centres are advised to emphasise the correct use of units.

(b) Candidates were to analyse and use the given unfamiliar structure to apply knowledge and understanding of formulas and structures. The question was poorly done as candidates showed low skill in writing formulae.

i Most candidates were able to show understanding of formulae of organic acids and homologous series hence identified the functional group of the acid as the COOH group.

ii Candidates were to deduce the empirical formula from a given structural formula and most candidates gave the molecular formula $C_3H_6O_3$ instead simplifying it to CH_2O hence lost marks. Centres are advised to emphasise the difference between molecular and empirical formula.

iii This part question required candidates to write a chemical equation for the partial ionisation of lactic acid and was poorly done by the majority of candidates. Most candidates could not write the correct formulae of the acid and/or resulting ions. Common responses such as H_2 and H_2^+ were given as products and did not score. Majority of Candidates also did not recognise that partial ionisation is reversible.

$C_2H_4(OH)COOH(aq) \quad C_2H_4(OH)COO^-(aq) + H^+(aq)$

(c) The question dealt with fermentation of carbohydrates and was done well.

i This part question was fairly done as candidates were able to recognise that fermentation is the breakdown of carbohydrates with some candidates not mentioning what causes the breakdown, hence, losing the mark.

ii Candidates did well in this part question as they gave the correct products of fermentation giving carbon dioxide and ethanol as the common responses.

(d) The question dealt with the formation of an ester methyl ethanoate. Candidates were to draw the structure of the ester given the molecular formulae of the reactants. The question was fairly done as some candidates lost marks for drawing structures with some bonds missing while others drew the structure of ethyl ethanoate which did not score. Centres are advised to emphasise drawing structures of different esters.

3. This question was about rate of reaction using the reaction between dilute hydrochloric acid and sodium thiosulphate and required candidates to show their skills in interpretation of state symbols in an equation, drawing graphs as well as drawing conclusions. The question was fairly done.

(a) This part question was poorly done as majority of candidates failed to recognise that the formation of sulphur precipitate was responsible for making the cross invisible. Centres are advised to emphasise the interpretation of state symbols in deducing observations from given equations.

(b) This part question dealt with the skill of transforming data from one form to the other and interpretation of the experimental results. And the part question was fairly performed by the candidates.

i Candidates were expected to plot a graph using points given in the table and compared to the previous years there was some improvements shown I terms of the quality of the graph produced.

Most of the candidates were able to score at least 2 out the four marks. Candidates were able to label axes with correct units, choose a correct scale and plot points correctly. However, some candidates had inappropriate scales and most candidates lost marks for joining points with a smooth curve as some were using a rule to join the points.

ii This part question was poorly done as majority of candidates were not able to come up with the conclusion that increasing the concentration increases the rate of reaction but instead stated the results. Common response was increasing the concentration increases the time which did not score. Centers are advised to emphasise how to draw a conclusion given resultsThis part question was poorly done as majority of candidates were not able to come up with the conclusion that increasing the concentration increases the rate of reaction but instead stated the results. Common response was increasing the concentration increases the time which did not score. Centers are advised to emphasise how to draw a conclusion given results.

(c) In this question candidates were expected to show their understanding of effect of temperature on the rate of reaction. The question was fairly done.

i Candidates were to explain the effect of increasing temperature on the rate of reaction in terms of particles and the part question was done well as the majority of candidates were able to state that increasing the temperature increases the energy of the particles leading to more frequent collisions which increases the rate. However few candidates lost marks for responses such as increase in reaction and faster rate.

ii This part question was poorly done by most candidates. The question required candidates to sketch a graph showing the effect of increasing the temperature on the rate of the reaction between sodium thiosulphate and hydrochloric acid. Candidates showed lack of understanding that when the rate is higher the time is shorter hence the graph will be below the original curve. Most candidates who were able to realise that the curve should be below the original scored only one marks since candidates either lost marks for having curves that were having a concentration of zero as well as starting or having graphs with the same initial and stopping times despite the higher temperature. Centres are advised to emphasise sketching of graphs to show effect of various factors on the rate of reaction as they are being changed.

(d) This question about sulphur dioxide as a pollutant was fairly done. Candidates were expected to show knowledge of sulphur dioxide as a pollutant and be aware of what is happening in their immediate environment.

i Candidates were to give a source of sulphur dioxide and the question was fairly done. Some candidates gave response like mines and fossil fuels instead of burning fossil fuels which did not score.

ii This part question was done well by most candidates giving acid rain as a common response for the adverse effect of sulphur dioxide in the atmosphere.

iii This question required candidates to state how sulphur dioxide emissions to the atmosphere can be reduced and was poorly done.

Candidates gave the use of catalytic convertors as a common response, hence lost the mark.

iv In this part question, candidates were expected to show knowledge of uses of sulphur dioxide and was done well as candidates gave production of sulphuric acid and food preservation as common responses.

4. The question required knowledge of the properties of group one elements ionic bonding, their reaction with water and preparation of salts of group one metals and was fairly done. Candidates showed lack of knowledge that group one hydroxide are strong alkalis.

(a) This part question required candidates to compare the reactivity of lithium and potassium and give an explanation. Most candidates gave potassium as the more reactive metal but could not fully explain their choice as it is a larger atom which easily loses the outer shell electron due to a weaker nuclear attraction. Centres are advised to emphasise explanation of reactivity.

(b) This question on ionic bonding required candidates to draw a dot and cross diagram to show the bonding in sodium oxide. There was an improvement on how electrons are distributed and the quality of diagrams was good.

i This part question was fairly done. Even though most candidates were able to show that metals and non- metals react by transfer of electrons some candidates lost marks for using sodium instead of potassium, incorrect charges like K^{2+} and not showing the correct ratio of ions. Most candidates scored 2 out of 3 marks. Centers are

advised to emphasise the drawing dot and cross diagrams for ionic structures

ii Candidates did well in stating one property of ionic compounds and centres are applauded for this

(c) This question dealt with the reactions of group one metals with water was fairly done.

i Candidates showed understanding of reactions of group one metals with water hence gave correct observations made during the reaction of sodium with water while few candidates lost marks for writing metal disappears

ii This part question was poorly done since candidates showed lack of understanding that sodium hydroxide is a strong alkali hence gave pH values ranging from 8 to 10 which did not score. Centres are advised to emphasise the pH scale in relation to strength.

(d) This question focused on test for the presence of water and obtaining pure salt from solution and was fairly done.

i This part question required candidates to give a test for the presence of water and was fairly done. Candidates gave cobalt chloride paper and anhydrous cobalt (II) chloride as common responses while others gave anhydrous copper (II) sulphate. A good number of candidates showed correct colour change with some candidates giving wrong colours while others lost marks for not showing that the anhydrous salt is used.

ii In this part question candidates needed to describe how pure dry crystals may be obtained from solution and was fairly done. Most candidates gave heat the solution to saturation and then some lost marks for writing cool the crystals instead of cooling the solution to form crystals. Most candidates did not pay attention to purification of the salt, hence omitted washing of the crystals. Some candidates lost marks for drying the crystals in an oven. Centres are advised to emphasise steps for obtaining pure dry salt crystals.

5. The question required candidates to show skills on dealing with organic chemistry concepts like polymerisation and cracking in addition to calculations involving stoichiometry. Candidates were also expected to show awareness of pollution This question was fairly done.

(a) Candidates were expected to identify the type of polymerisation given a monomer and apply their knowledge and understanding to draw the structure of the resulting polymer and was poorly done.

i This part question was fairly done as some candidates were able to realise that butadiene and styrene have double bonds and therefore undergo addition polymerisation. Some candidates lost marks for responses like condensation and additional.

ii This was poorly done as only few candidates were able to draw the correct structure while majority of candidates lost marks for drawing wrong structures where either atoms were rearranged, double bonds

not opened and carbon bonded with five bonds, different polymers drawn or structures with missing bonds. Centres are advised to emphasise addition polymerisation using different monomers.

iii This part question required candidates to identify styrene-butadiene as a synthetic macromolecule that will lead to pollution and was done well by majority of the candidates.

(b) The question dealt with cracking of butane and was fairly done.

i Most candidates were able to state the conditions for cracking. Common responses were high temperature and named catalysts. Centres are applauded for this achievement.

ii Candidates were expected to write a balanced chemical equation for the cracking of butane to produce butadiene and this part question was poorly done by majority of the candidates. Candidates lost marks for writing wrong chemical formulae and not showing the other product. Some candidates, who recognised hydrogen as the other product failed to give the correct formula for hydrogen like H_4 instead of $2H_2$, hence lost marks. Centres are advised to use different reactions to emphasise cracking and use equations.

(c) This question on calculations using stoichiometry was done well by most candidates but some lost marks for wrong use of stoichiometry. Centres are applauded for the job well done.

i This part question was done well as majority of candidates were able to calculate the number of moles of carbon dioxide.

Answer: 0.1458

ii Majority of candidates used the correct ratios to calculate the number of moles of butadiene (0.03645) while few candidates lost marks for not using stoichiometry correctly giving 2 as a response.

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Answer: 0.125

ii Most candidates calculated the mass correctly while some lost marks for using incorrect molecular mass of butadiene, omission of units or incorrect rounding of the answer.

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Answer: 1.97 g

6. This question required candidates to show understanding of electrolysis of aqueous electrolytes and carry out calculations to determine the amount of products made during electrolysis. The question was fairly done by majority of the candidates.

(a) This question required candidates to describe what happens during the electrolysis of aqueous sodium chloride and give explanations. The question was done well.

i Candidates were expected to identify aqueous sodium hydroxide as an electrolyte and then identify all the ions present. Most candidates showed understanding of ionisation of ionic compounds and gave sodium, hydrogen, chloride and hydroxide ions but some candidates lost a mark for writing chlorine. Some candidates who gave formulae of the ions lost marks for incorrect formula giving common responses such as Cl_2^- and H_2^-**.** Centres are advised to emphasise Chemical formula.

ii Most candidates were able to name gas X as hydrogen.

iii This part question required candidates to identify the electrode where chlorine gas was produced and give an explanation for their answer. Most candidates gave the anode as negative ions get discharged at the positive electrode. Few candidates gave the cathode hence lost marks.

(b) This question candidates were required to recognise that at the end of electrolysis an alkaline solution, sodium hydroxide remains in solution which will turn the red litmus paper to blue and was done well by most candidates.

(c) The question was fairly done. The question required an explanation of the bleaching action of chlorine. Chlorine dissolves in the water to produce hydrochloric acid and hypochlorous acid, then the hypochlorous acid oxidises the dye making it to lose colour. Some candidates lost marks for not making reference to the products.

PAPER 4

GENERAL COMMENTS

Majority of the candidates in the 2023 cohort have shown great skills in data presentation in the table and also good reporting skills on qualitative analysis. The candidates have shown knowledge and understanding of accuracy of the burette. However, the candidates have shown deficiency on calculating the moles from a stock solution. This is evident because of question 1(b) and 1(d), where the candidates used the pipette volume instead of the volume of acid used. Some candidates ended up losing marks for 1c(i), 1d (i), 1d(ii) and 1d(iii).

Treatment of results on the table was well understood by majority of the candidates. However, few candidates did not quote the correct significant figures as demanded by the questions and the syllabus. Candidates that obtained an answer at 1 significant figure from the calculator should aware of the expectation by inspecting the question.

Comments on individual questions

1 The question was on titration. The majority of the candidates across the centres did very well in the question.

(a) The question assessed the candidates in accuracy, concordance and average. The majority of the candidates across the centres did very well in the part question. Data presentation and treatment of results was well done across the centres.

Accuracy: Majority of the candidates scored maximum marks on accuracy of the titres. Centres are encouraged to continue performing their experiments for each session to advantage the candidates. Solutions may change with time so each session may have its supervisors value.

Concordance: Most candidates scored maximum marks. The 2023 cohort, just like the previous candidates showed great skills on treatment of results. There were minimal errors on subtraction and decimal point.

Average: The average mark was also scored by most candidates.

Ticking or treating results: Most candidates ticked the values correctly. This indicates that majority of the candidates understood the rationale behind ticking the values. Centres are still encouraged to continue explaining and emphasizing the importance of treating titres in quantitative analysis. [**The closer the titres the more likely the values are accurate]**.

(b) This part question was well done. Majority of the candidates scored the mark showing good understanding of stoichiometry. Those who failed to score the mark mostly it was due to significant figures albeit a few.

Significant figures were penalised once and as a result if penalised in (b), candidates scored a mark in subsequent part questions.

(c) (i) This part question was well done. Candidates were comfortable with mole ratio and the ratio was 1:1 to make this mark easily accessible [2:2 from equation].

(ii) This part question was fairly done. Candidates realised the number of moles needed was the moles in given solution. This shows a great improvement compared to previous years. Those centres whose candidates did not do well in this part question, was due to fact that the candidates divided 1 dm^3 by average volume in cm^3 instead of dm^3.

(d) (i) This part question was fairly done. Candidates realised the number of moles needed was the moles in stock solution. This shows a great improvement compared to previous years. Those centres whose candidates did not do well in this part question, was due to fact that the candidates divided 250 cm^3 by average volume instead of the pipette volume which is 25 cm^3.

(ii) This part question, candidates were to calculate the mass of X in the formula X_2CO_3, the part question was well done.

(iii) Candidates who did not get this part correct are those who did not realise X is a monovalent metal.

Assume that 25.0 cm^3 of S (X_2CO_3) required 25.0 cm^3 R (HCl).

(b) 0.00250 (c)(i) 0.00125, (c)(ii) 0.05 (d)(i) 138 (d)(ii) 39 (d)(iii) potassium, K

2 This question tested the candidates on qualitative analysis skills. The candidates were provided with solid **T** (mixture of two solids, $FeCl_2$ and NH_4Cl) to identify the cations in the mixture and eventually write the formula of one of the salts in the mixture. The question was well done. The majority of candidates made correct observations but some candidates failed to record them in a scientific language. The reporting led to candidates either contradicting themselves for instance reporting formation of solution and precipitate at the same time or reporting everything for the same observation for examples formation of precipitate and solubility. Just like in the previous years, candidates lost marks on solubility of precipitates as a result of recording solubility too early e.g. at b(i) and c (i) instead of at b(ii) and c (ii).

(a) Most candidates reported yellow solution in this part question. Most candidates reported that solid T dissolves but lost this mark because of stating “forming a yellow solution”..

(b) (i) This part question was on formation of a precipitate. It was well done. Most candidates reported ‘green ppt’ and scored both marks. In cases where they lost mark, they had reported yellow precipitate hence score one mark. Most candidates this year did not confuse residue with a precipitate. Centres are commended for a good job done.

(ii) This part question on solubility of the precipitate. It was well done. Candidates that lost the mark would have reported solubility at b(i). centres are commended for sensitizing candidates on when to report for solubility of precipitates.

(iii) The part question was fairly done. Candidates did test for ammonia gas correctly. Candidates that lost a mark had failed to identify the gas. Candidates that lost the 2 marks had failed to state that “damp” red litmas paper was used.

(c) (i) This part question was also on formation of a precipitate The part question was well done. The candidates reported a green precipitate and scored a mark.

(ii) The part question was fairly done. The candidates that lost a mark just like at b(ii) had reported about solubility at c(i).

(d) (i) This part question was well done. The candidates reported white precipitate.

(ii) This part question was on fairly done. The candidates were looking for solubility of the ppt in excess sliver nitrate rather than acid. Centres are encouraged to motivate candidates to always read the question and understand why a test is done.

PAPER 5

General comments

The majority of the centres did fairly well on this paper. Data presentation was somehow well done. The candidates showed great improvement on the application of significant figures. The candidates recorded correctly the accuracy of the burette. The reporting on qualitative analysis and conclusions has realty improved compared to the previous years.

Comments on individual questions

1 The question examined the candidates on quantitative analysis skills, where they were to determine the mass of X_2CO_3 from a given stock solution. Generally, the question was fairly answered by this cohort.

(a) i The part question was on colour of methyl orange at end point. The part question was well done. Centres are encouraged to emphasis the end point of titration reaction and explain what happens at and after end point in terms of the solute in the conical flask.

ii The part question was on the suitable instrument to be used to measure accurate mass. The question was poorly done.

(b) i The part question was on titration and candidates recording the burette readings from the diagrams given. Centres are commended for a good job done in training their candidates. Most of the candidates showed that they were well equipped with skills on data presentation and results treatment. The candidates showed proper skills in dealing with the results as they correctly ticked titres that are

closest to each other. Centres are encouraged to continue advising their candidates on why ticking is important, it is not just done randomly, but done for a purpose. Ticking results is not for calculating the average volume of acid used to neutralise 25.0 cm^3 of alkali, but treating results to obtain accurate findings..

ii Most centres did well in this question. Candidates have improved in calculating average and to the correct significant figures. A few candidates who failed to score failed to tick or show which values were used from the table to calculate the average.

(c) This part question was well done. Majority of the candidates scored the mark showing good understanding of stoichiometry. Those who failed to score the mark mostly it was due to significant figures albeit a few. Significant figures were penalised once and as a result if penalised in (c), candidates will scored a mark in subsequent sub questions irrespective of their significant numbers.

(d) i The part question was well done. Candidates were comfortable with mole ratio and in this question it was 1:1 which makes the mark easily accessible.

ii Candidates were to find the number of moles in stock solution. This part question was fairly done. This shows a great improvement compared to previous years. Those centres whose candidates did not do well in this part question, was due to fact that the candidates divided 1 dm^3 by average volume of acid in cm^3 instead of dm^3.

(e) i This part question was well done. Centres correctly used mass and moles of the X_2CO_3 to calculate the relative molecular mass (RMM) of the compound.

ii The part question was poorly done. This part question, candidates were to calculate the mass of X. candidates did not realise its simple addition of relative atomic masses to get the RMM found at (e)(i).

(f) This part question was fairly done. Centres correctly identified X except those who did not realise X is monovalent.

(e) Candidates did show lack of knowledge on why apparatus are not cleaned using a test solution. The part question was poorly done.

Assume that 25.0 cm^3 of S (X_2CO_3) required 25.0 cm^3 R (HCl).

(b) 0.00250 (c)(i) 0.00125, (c)(ii) 0.05 (d)(i) 138 (d)(ii) 39 (d)(iii) potassium, K

2 This question tested the candidates on qualitative analysis of solid **T** (mixture of two solids, $FeCl_2$ and NH_4Cl). The candidates were requested to give observations and possible tests given some information and conclusions made on the sample. This question was well done.

(b) i In this part question the candidates were to give the observations based on the conclusion given (Fe^{2+} suspected). The mark was easily accessible.

ii The part question was well done. The majority of the candidates gave the expected observation that is **ppt** dissolves in excess sodium hydroxide. Centres are encouraged to coach their students on

solubility of precipitates. Most candidates talked about solubility before even adding excess alkali.

iii This part question was fairly done. Most candidates reported either '**pungent smell or damp red litmus turns blue**' and scored a mark but failed to conclude that **NH_4^{+1}**.

(c) i Centres are advised to emphasise the purpose of testing anions and cations, which is to identify and confirm the ion tested. Centres should explain to candidates why excess alkaline solution is added, [be it for solubility or and amphoteric]. Candidates lost a mark in c(ii) because they had talked of solubility of the precipitates at (c)(i).

ii The candidates had to write then add **excess (hydroxide)** but they wrote excess ammonium which did not score. It was poorly done.

(d) This part was on identification of the anion in solid T. The part question was well done. Most candidates reported silver nitrate and white ppt. The mark for addition of nitric acid was not accessible.

(e) The candidates had to identify salt **T** ($FeCl_2$ or NH_4Cl). The part question was fairly done.

3 This question was on reactivity of metals. The candidates displayed lack of knowledge on this subject matter. Centres performed poorly in this question.

(a) Candidates were to state the apparatus needed to carry out a reaction given a solution and a solid. The question was well done.

(b) The part question was on reactivity of metals. Candidates performed poorly on this part question. Candidates understood the concept of reactivity but showed lack of skills needed to carry out an experiment and how the experiment is done.

(c) Centres did well on the part question as they were able to use their prior knowledge to come up with the reactivity series.

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