PRINCIPAL EXAMINER'S REPORT

BOTSWANA EXAMINATIONS COUNCIL

BSSE CHEMISTRY

2025

PAPER 1: WRITTEN PAPER

General Comments

Most candidates showed good mathematical skills as they were able to score marks in the questions that involved calculations i.e. stoichiometry, calculation of enthalpy change. Centres are commended for the good work however centres should emphasise on calculations of relative molecular mass, Mr, of compounds as marks were lost were Mr had to be used. Candidates showed lack of understanding in answering questions that required them to describe or explain concepts e.g. describing tests or explaining properties as they stated the tests and the properties instead. Questions that required definitions were also a challenge to most candidates. Centres are advised to emphasise on the mentioned areas. Candidates showed lack knowledge on the topic of electrolysis, centres are encouraged to emphasise of the topic as the question was poorly done.

Comments on Individual Items

1 The question required candidates to show knowledge on allotropes of carbon and was fairly done. Most candidates showed lack of understanding on how the properties of the allotropes relate to their uses.

(a) The question was fairly done. Most candidates failed to define allotropes as different forms of an element existing in the same physical state, instead phrases like 'different structures or elements or molecules' for different forms were used which led to loss of the mark. Most candidates also had a challenge in defining macromolecules as giant molecules made on many small molecules or atoms. The responses given by candidates did not emphasise on the large number of the small molecules e.g. two or more molecules was used to refer to many molecules or atoms, while other candidates used repetition of the small molecules which refers to only one group of macromolecules i.e. polymers. Centres are encouraged to emphasise on the definition of the common terms in Chemistry as a whole.

(b) The question required candidates to show knowledge on the use of graphite as a lubricant, and it was fairly done. Most candidates showed lack of knowledge on what causes the sliding of the layers of carbon atoms i.e. weak forces between them creating a slippery surface and lost a mark. Some candidates stated that the weak forces are between molecules, atoms, structures or sheets of layers and those slide instead of layers of carbon atoms which did not score. The other common wrong response was graphite is soft and slippery which did not score for the explanation of why graphite is used as lubricant. Centres are advised to emphasise on how the structure of graphite relate to its uses.

(c) The question was well done. Most candidates were able to state the uses of diamond and the properties related to the uses. Common correct responses were making drill bits or cutting tools because it is hard and making jewellery because it is shiny. Some candidates lost marks because they swapped the property and use. Common responses which did not score were making drilling tools, drilling machines and as jewellery. In some cases, the property of jewellery was given as hard and shiny which did not score. Centres are advised to encourage candidates to follow instructions in the question paper and give specific properties to uses.

2 This question was about understanding the mole concept, and it was well done. Majority of the candidates showed good mathematical skills in calculations of percentage composition, conversion of volume of solutions to moles, moles to mass and stoichiometry. Answers were rounded off and presented to the correct number of significant figures. Centres are commended for that. However, Centres are encouraged to emphasise on calculation of relative molecular mass, M_r, of compounds as marks were lost in calculations that required use of M_r.

(a) Candidates were required to calculate the percentage of nitrogen in ammonium sulphate. The question was fairly done, some candidates failed to recognise that there two atoms of nitrogen in the compound hence lost a mark as compensation mark was given for correct relative molecular mass of ammonium sulphate if units g/mol were not attached. This led to 10.6% as the common wrong answer instead of **21.2%.** In other cases, the calculations were done correctly i.e. [28/132 x 100] but a mark was lost when candidates failed to round off the answer correctly, common wrong answer was 21.1%. Centres are encouraged to advice candidates to avoid losing marks on low order questions.

***Answer*:** 21.2%

(b) The question was fairly done. Some candidates showed understanding in splitting ionic compounds into ions but failed to balance the charges of the ions. Centres are encouraged to emphasise on that.

(i) This part question was fairly done. Most candidates scored the mark for splitting the compounds in aqueous states into ions and cancelling spectator ions but failed to balance the charges of Fe^{2+} and OH^- ions hence lost a mark. Some candidates failed to score a mark as they used wrong formulae such as Fe(OH), Fe^+, OH^+ or Fe^{2-}.

(ii) Candidates were required to show knowledge on separation of solids from solutions, and it was poorly done. Most candidates interpreted the question wrongly as common wrong responses were crystallisation, precipitation, titration instead of filtration hence the mark was lost. Centres are advised to train candidates on interpretation of questions to avoid loss of marks in low order questions.

(c) The question was well done. Most candidates showed understanding on conversion of moles to other quantities and stoichiometry. Centres are commended for emphasising that skill.

(i) This part question was well done. Most candidates showed skill in converting 22.5 cm^3 to 0.0225 dm^3 and used the volume correctly with the concentration to get 0.000450 moles and scored 2 marks. The answer was presented to correct significant figures. A few candidates divided 22.5 cm^3 by 100 instead of 1000 and lost the marks. Some candidates used the volume of aqueous $FeSO_4$ i.e. 25.0 cm^3 to calculate the moles of $KMnO_4$ which did not score.

***Answer*:** 0.000450 moles

(ii) Candidates were required to use the mole ratio and relative molecular mass of $FeSO_4$ to calculate the mass, and it was fairly done. Majority of the candidates were able to use the mole ratio correctly but failed to calculate the correct relative molecular mass of iron(II)

sulphate and lost a mark. Some candidates calculated the relative molecular mass of iron(II) sulphate correctly as 152 but failed to use the mole ratio, common wrong answer was 760 g which did not score. Correct responses were given to correct significant figure i.e. at least 2 significant figures.

Answer: 0.342 g

3 The question was generally fairly done. Candidates were required to show knowledge on Group VII elements and their metal compounds. Challenges to describe tests and explain concepts by candidates were evident in this question, Centres are encouraged to emphasise on those.

(a) This part question was fairly done. Candidates were required to describe test for chlorine but instead some stated the test which did not score. The response needed is insert a damp litmus paper into the gas and the damp litmus paper is bleached. Common wrong describing words used were 'deep' for dip and 'dump' for damp. Common wrong results given were damp red litmus turns blue or colourless. Some candidates described test for chloride ions instead of chlorine gas which did not score.

(b) The question required candidates to show understanding on bonding in ionic compounds by drawing a dot and cross diagram showing bonding in calcium chloride and it was fairly done. Some candidates drew correct labelled structures of calcium ion and two chloride ions and scored three marks. Marks were lost when structures were not labelled either by symbols or number of sub-atomic particles in the nucleus, not showing all electrons in the structures of the ions, swapping the charges of the ions i.e. –1 for calcium ion and +2 for chloride ions or using wrong magnitudes for the charges of ions i.e. –2 for two chloride ions and +1 for a calcium ion. Most candidates were able to identify calcium chloride as an ionic compound and draw structures of ions, Centres are commended for the improvement.

(c) The question is about properties of ionic compounds, and it was well done. Most candidates showed knowledge on the concept. Explanation for the electrical conductivity of calcium chloride in molten or in solution was a challenge for some candidates showing lack of understanding. Centres are advised to emphasise of explaining the properties of ionic compounds.

(i) This part question was fairly done. Candidates were required to show understanding on electrical conductivity of ionic compounds in molten or in solution. Most candidates lost marks as the related the electrical conductivity of the compounds to movement of electrons or molecules instead of free mobile ions. Common wrong response was calcium chloride has delocalised electrons.

(ii) The part question required candidates to state one other property of ionic compounds other than conduction of electricity in molten or solution state, and it was well done. Few wrong responses were low melting and boiling points, non-volatile and crystalline at room temperature and pressure.

(d) The question required understanding on reactivity series of the group VII elements, and it was well done.

(i) This part question was fairly done. Most candidates were able to recognise that there will be no reaction because astatine is less reactive than chlorine. Candidates' responses showed that they had an idea of a displacement reaction, but some lost a mark for failure to compare reactivity of astatine to chlorine.

(ii) The part question required candidates to show understanding on working out formulae of ionic compounds i.e. calcium astatide and construct an equation. Some candidates failed to recognise that the valency of calcium is two while others used brackets in the formula of calcium astatide. Common wrong formulae were CaAt and $Ca(At)_2$ instead of **$CaAt_2$**. Centres are encouraged to emphasise on working out formulae of compounds.

4 The question was on energy changes. Candidates were required to show knowledge on labelling energy level diagrams and calculation of energy change from bond energies. This question was well done.

(a) This part question was well done. Most candidates were able to label the energy level diagram but some lost marks due to use of words reactants and products instead of the reactants and products from the given equation i.e. $N_2 + O_2$ and 2NO , labelling enthalpy change as enthalpy, elaborating on the correct given labels leading to contradiction e.g. identifying Z as delta H (ΔH is negative), abbreviating activation energy as EA instead of E_a. Centres are advised to emphasise those.

(b) The question required candidates to state the type of the reaction represented by the energy level diagram with justification and it was fairly done. The mark for justification was not accessible to most candidates, common wrong responses were products more than reactants instead of the energies, activation energy is more than energy change.

(c) The question was well done. Candidates were to calculate the total energy required to break bonds and total energy released when bonds form.

(i) This part question was well done. Most candidates were able to add the bond energies of one mole of N_2 i.e. 946kJ and of O_2 i.e. 498kJ to obtain +1444 kJ. Common wrong answer was +2888 kJ from (2 × 946) + (2 × 498). Some candidates lost 1 mark for omitting the sign or units. Common wrong units were $kJmol^{-}$ / mol. Centres are advised to emphasise that bond breaking is endothermic and total energy should have a positive sign.

(ii) The part question was well done. Most candidates got –1214 kJ as the correct answer. Few candidates lost a mark for omitting the sign or units. Centres are advised to emphasise that bond breaking is exothermic, and the total energy should have a negative sign.

(iii) The part question required the candidates to calculate the total energy of the reaction, and it was well done. Common wrong responses were those that lead to a negative ΔH though the reaction is endothermic. Centres are advised to emphasise on the formula for calculating ΔH.

***Answer*: (i)** 1444 kJ **(ii)** 1214 kJ **(iii)** 230 kJ

5 The question required candidates to show knowledge and understanding on manufacture of sulphuric acid by the contact process and it was poorly done. Centres are encouraged to emphasise on the reaction that occurs in the contact process.

(a) The part question was fairly done. Some candidates were able to give the sources as metals ores containing sulphur, volcanic eruptions, natural gas, coal, crude oil. Common responses which did not score were natural air, burning or combustion of fossil fuels, natural element in United Kingdom without emphasis of the volcanic regions. Centres are encouraged to emphasise of the difference between sources of sulphur and those of sulphur dioxide.

(b) Candidates were required to show knowledge on the contact process, and it was poorly done.

(i) The part question was poorly done. Most candidates failed to use a reversible arrow and lost the 2 marks. Some candidates used the reversible arrow but failed to balance the equation, hence lost a mark.

(ii) This part question was well done. Most candidates were able to give 450 °C as the suitable temperature used in the contact process and scored a mark. Common wrong answers were 450 °C and 300 °C. Centres are advised to emphasise on the correct units for temperature.

(iii) Candidates failed to explain why sulphur trioxide is directly dissolved in water and it was fairly done. Common wrong responses were, sulphur trioxide reacts vigorously with water, reaction is dangerous or corrosive or harmful. Common correct responses were sulphur trioxide reacts violently with water, reaction is highly exothermic, acidic fumes or mist produced.

(c) The part question was poorly done. Most candidates use relative molecular mass of anhydrous copper(II) sulphate, 160, instead of 250 for hydrated copper(II) sulphate and got 2.8 g which did not score.

Answer: 1.80 g

(d) This part question was fairly done. Most candidates were able to give the colour of hydrated copper(II) sulphate as **blue** but failed to recognise that when heated it becomes anhydrous and turn **white** hence gave wrong responses such as it turns colourless, black while others swapped the colours i.e. white to blue. Centres are advised to encourage candidates to follow instructions given in questions.

6 Candidates were required to show knowledge and understanding on polymers and it was fairly done. Centres are encouraged to emphasise on formation of macromolecules.

(a) The question was well done. Most candidates were able to name the linkage as the ester linkage except for a few with wrong spelling like esther, easter which did not score. Centre should emphasise of the correct spelling.

(b) Candidates were expected to show knowledge on unsaturated compounds, and it was fairly done.

(i) This part question was poorly done. Common wrong responses were double bond between atoms instead of carbon atoms, double carbon-carbon bond instead of carbon-carbon double

bond, addition of compound or element instead of more atoms. Responses which scored a mark were compounds with a carbon-carbon bond(C = C), multiple bonds, which add more atoms. Centres are advised to emphasise on the definition of unsaturated.

(ii) Candidates were required describe a test that distinguish saturated fat and unsaturated fat, and it was fairly done. Some candidates failed to describe the test using terms that show addition of bromine water, described emulsion test, used potassium dichromate which is incorrect for testing unsaturation in fats, swapped results for saturated and unsaturated fat and lost marks. The expected responses are add bromine water to saturated and unsaturated fat for testing, and bromine water remains brown or orange or yellow as a result for saturated fats and brown or orange or yellow bromine water turns colourless as a result in unsaturated fat

(c) This question was well done. Most candidates were able name terylene with a correct spelling and scored the mark, centres are commended for that. Common wrong responses were polyester, nylon which did not score.

(d) Candidates were expected to show understanding on formation of nylon and its disadvantages in the environment, and it was well done.

(i) The question was well done. Most candidates were able to draw the structure of part nylon showing the amide linkage, open ends and atoms correctly bonded in a polymer. Marks were lost if one of the mentioned was not shown, box of the diamine not shaded and by the few who joined amino acids instead of the monomers given in the question.

(ii) This part question was well done. Most candidates gave the disadvantage as land or water pollution as nylon is non-biodegradable. Common wrong responses for the disadvantage were air pollution, non-biodegradable, littering while for the explanation they gave ‘difficult to decompose’ for non-biodegradable which did not score.

(e) The question required candidates to show understanding on hydrolysis of proteins and describe steps for identifying amino acids using chromatography. It was poorly done. Most candidates failed to hydrolyse the insulin into amino acids before separation. Some candidates had an idea on chromatography but failed to lay out the procedure. Common wrong responses included; the mixture of insulin and amino acid spotted onto a chromatogram instead of a chromatography paper, failure to dip the chromatography paper to a level below the starting line, spraying the chromatography paper before dipping into the solvent. Few candidates were able to score a mark for spraying the chromatography paper with a locating agent while very few candidates scored the mark for comparing the distance travelled by components of insulin mixture, proline and lysine using diagrams while others compared calculated Rf values. Centres are encouraged to emphasise the steps of chromatography to candidates.

7 This question was on electrolysis. The candidates displayed lack of knowledge on this subject matter. Centres performed poorly in this question, and they are encouraged to emphasise the concepts of the topic to candidates.

(a) The question required candidates to show understanding on electrolysis of dilute copper(II) chloride using carbon electrodes and it was fairly done.

(i) This part question was fairly done. Some candidates were able to identify the cathode as B but failed to justify their answer by its connection to the negative terminal instead gave wrong responses such as; it on the negative terminal, at the negative terminal, it is the negative terminal and lost the mark.

(ii) This part question was fairly done; some candidates were able to identify hydroxide ions as the ion discharged by losing electrons at the anode for oxygen to be produced. Common wrong responses which did not score were OH^- ions discharged to give oxygen and hydrogen gas, anode attract Cl^- and OH^- ions and produce oxygen gas, OH^- ions loose electrons. Some candidates used the equation correctly and scored the 2 marks i.e. $4OH^- \rightarrow 2H_2O + O_2 + 4e$.

(b) Candidates were required to explain the observation at the cathode and the question was poorly done. Some candidates gave the correct response and cancelled it and gave bubbles because of H^+ ions gain electrons which did not score. Correct answer is; - brown solid forms as copper(II) ions gain 2 electrons forming copper. Common wrong responses were formation of a brown colour, brownish substance, brown precipitate and copper ions discharged instead of copper(II) ions.

(c) The question was poorly done. Candidates were to explain what will happen at the cathode when dilute copper(II) chloride was replaced by concentrated copper(II) chloride, and the failed to recognise that they will be more copper(II) ions in the electrolyte. The answer is more brown solid forms faster as there will be more copper(II) ions in the electrolyte. Common wrong responses were formation of brown solid or deposit or copper, cathode increases in size, electrolyte become blue or green and did not score. Some candidates interpreted concentrated in the question as addition of more water hence more H^+ which did not score. Centres are encouraged to emphasise the concepts of electrolysis to candidates.

PAPER 2: PRACTICAL PAPER

General Comments

All centres are encouraged to perform the experiments in paper 2 and send their reports. This will help the examiners to mark the candidates according to the results obtained by their supervisors. Centres that did the experiments and sent the supervisors' values are commended. Those centres that provided the report, answered all questions on the question paper, made the marking easy and also help their candidates because the candidates would not loose marks unnecessarily. Centres are encouraged to report what is observed, and follow the instruction sheet well, this will help the candidates. The general performance of the paper was poor especially titration task.

Some centres are commended for taking note of problems associated with scientific reporting. However, there were some centres which did not report the supervisors' value as expected, either they did not give it or they gave a range. This works as a disadvantage for the candidates because for centres without a supervisors' value or with a range given, then the average of candidate's titre is used as the supervisor's value. For those centres that did report the supervisors' value, some gave their values to two (2) decimal points. Therefore, Centres are encouraged to give their titre values to one decimal point.

It was observed that, in some Centres the candidates rounded off their calculated values on each and every question thereby adding error to the expected final answer. Therefore, Centres are encouraged to advice their candidates to continue using values on their calculators rather than to round-off the values. This practice helps candidates to use the most accurate value during calculations and also to be able to score marks on the subsequent questions not by error carried forward after rounding off. And lastly though the subsequent questions are of one mark most of the time, working must be shown.

It was observed that Question 1 (quantitative analysis, titration) was poorly done compared to question 2 (qualitative analysis) and 3 (rates of reaction). For the centres that did well, the reporting on concordance and titration was good. Reporting on solubility of precipitates was a challenge for some centres. Centres should emphasise that the scientific way of adding the alkali to a test solution is to add gradually and make observations until the alkali is in excess.

Question 3 was a challenge on plotting the graph, candidates did not recognise the correct orientation of the graph. The scale was also a challenge, and some candidates plotted volume against time instead of time against concentration.

The quality of answers in almost all centres for the 2025 cohort was very satisfactory on significant figures. Centres are encouraged to emphasise on significant figures and also to give more practices on significant figures because in quantitative analysis (question 1, titration) accuracy is the key.

This cohort, failed to score maximum points on high order questions for example 1(e), (f), (g), 2(b)(i), (ii), 2(c), 2(f). 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 emphasise testing and identification of any gas produced, for instance at 2(c).

Centres are advised to continue encouraging the candidates to answer every question in the space given, as this makes the e-marking processes or activities to be completed without delay. Some candidates did

match the observation they made with the test they did but for others it was a challenge. Centres are advised to encourage their candidates to report everything they observe to score maximum marks, for instance 2(c), candidates did not report that the solid under investigation dissolves. On another note, Centres are also advised to explain to candidates why excess alkaline solution is added, [be it for solubility or / and amphoteric]. It was observed that the 2025 cohort displayed good mathematical and computational skills in calculations. Centres are commended for imparting those skills to the candidates

Comments on Individual Items

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

(a) The question assessed the candidates in accuracy, concordance and average. The majority of the candidates across the centres did poorly in this part question. Data presentation and treatment of results was well done across the Centres, but marks were not scored because the candidates' values were outside the 0.6 of the supervisor's value.

Accuracy: Majority of the candidates did not score maximum marks on accuracy of the titres. Centres are encouraged to perform their experiments for each session to advantage the candidates and also record the supervisor's value not a range. Supervisors gave the range of students not what they found as supervisors. Solutions may change with time so each session may have its supervisor's value. If the solution is not stable, candidates be encouraged to start with the same question in a session.

Concordance: Most candidates did not score maximum marks due to wrong accuracy or values far away from the supervisor's value. The 2025 cohort, the candidates showed great skills on treatment of results albeit not scoring marks. There were minimal errors on subtraction and decimal point.

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 emphasising the importance of treating titres in quantitative analysis. The closer the titres the more likely the values will be accurate.

Average: The average mark was scored by most candidates as they used the ticked values.

(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 scored a mark in subsequent part questions.

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

(e) This part question was fairly done. Candidates realised the mole ratio is 1:2 which was easily accessible.

(f) This part question was not well done. Candidates did not realise that 3.45 g is the mass of impure compound in the stock solution. They took the number of moles straight from the ratio from the equation given. Others divided the mass by molar mass of copper.

(g) This part question was poorly done. Candidates did not realise the number of moles needed was the moles in given stock solution. This resulted in loss of marks. Centres should encourage candidate to use the number of moles that reacted and then work back to the original solution.

(h) This part question was well done as majority of the cohort managed to use their answer in (g) to calculate the mass of pure copper in the sample.

(i) This part question was well done as majority of the candidates were able to calculate the percentage purity of copper metal in the impure sample.

Answers: Assume that 25.2 cm^3 of U (sodium thiosulphate) required 25.0 cm^3 of solution T (I_2). **(c)** 0.00126, **(d)** 0.00630**,** **(e)** 0.00630 **(f)** 0.00630 **(g)** 0.0252 **(h)** 1.612 **(i)** 46.7%

or

with erratum**, (e)** 0.0126 **(f)** 0.0126 **(g)** 0.0504 **(h)** 3.2256 **(i)** 93.5%

2 This question tested the candidates on qualitative analysis skills. The candidates were provided with solid **R** (copper(II) carbonate) and liquid **S** (ethanol**)** to identify the ions in solid **R** and also identify the reaction that occurred in one of the tests involving S. The question was fairly done. The majority of the 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.

Some centres, supervisor report stated no observation or reported the ion that is in the reagent not in the test solution. Therefore, Centres are advised to put more effort in doing the Supervisor's report.

(a) This part question was well done as they majority of the candidates were able to make the right conclusion after the blue and red litmus papers remain unchanged i.e. they stated that liquid **S** is neutral.

(b) **(i/ii)** This part question was poorly done. The supervisors report stated something different from what the candidates reported. These two-part questions were on oxidising agents. Most candidates reported 'green ppt' and did not score marks. Centres are encouraged to emphasise to candidates which solutions are used to test for cations in test solutions.

(c) This part was poorly done. Candidates did not report R is dissolving or test the gas once they reported bubbles. Centres are encouraged to emphasise the importance of writing all observations during experiments.

(d) **(i)** The part question was fairly done. Candidates did report blue ppt but lost a mark for solubility. Either they wrote insoluble blue ppt or just blue ppt and not report on solubility of the precipitate.

(ii) This part question was also on formation of a precipitate The part question was well done. The candidates reported a blue precipitate and scored a mark. Some centres scored a mark by reporting dark blue solution.

(e) The part question was poorly done. The candidates lost a mark because they wrote copper(II) or iron(II) ions instead of their compounds.

(f) This part question was fairly done as a good number in the cohort managed to process the results and the information in the question to derive liquid S as ethanol. However, a good number too failed to score in this question as they gave ethene or ethanoic acid as their responses.

3 This question was on rate of reaction between sodium thiosulphate and hydrochloric acid. Majority of the centres scored 50 % of the possible marks available.

(a) **(i)** The part question was well done as majority in the cohort managed to follow the procedure given to investigate the effect of concentration on the rate of reaction using dilute hydrochloric acid and sodium thiosulphate solution. They managed to record the time taken by the cross to disappear when the two solutions reacted together.

(ii) This part question was well done as most of the candidates were able to use the formula given to by calculate the concentration of sodium thiosulphate solution and write the answer in the table.

(b) This part question was poorly done. For those candidates who plotted the graph well, the scale was not correct, or it did not cover 2/3 of the graph pad. Therefore, Centres are advised to give more practice to their candidates on plotting of graphs as this skill is basic in sciences.

(c) This part question was well done, candidates recognised that the concentration is inversely proportional to time, hence, they gave the relevant conclusion for the experiment.

(d) This part question was fairly done. Most candidates managed score one mark as they stated the error that can occur in this experiment but lost a mark on the explanation because they described the error and failed to explain how to minimise it.

PAPER 3: ALTERNATIVE TO PRACTICAL PAPER

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 was good. The 2025 group did very well on qualitative analysis and identification of unknown compounds.

Comments on Individual Items

1 The question examined the candidates on quantitative analysis skills, where they were to determine the percentage (%) mass of an impure substance. Generally, the question was well done by this cohort.

(a) (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 of the candidates scored the mark as they were able to name the apparatus that could accurately measure 25.0 cm^3 of iodine solution. The cohort showed understanding of instruments used for measuring accurate volumes.

(b) This part question was well done. Candidates in almost all centres did show understanding on calculating average mark, they used only the ticked titres to calculate the average volume of sodium thiosulphate used in the experiment.

(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 score a mark in subsequent sub questions irrespective of their significant numbers.

(d) This part question was well done. Candidates were comfortable with mole ratio and in this question, it was 2:1 which makes the mark easily accessible.

(e) This part question was on the use of stoichiometry. It was fairly done and the ratio was 1:1.

(f) Candidates were to use stoichiometry to find the number of moles of copper metal, instead they used the mass of the given impure copper compound. Majority of candidates did not score a mark.

(g) Candidates were to find the number of moles in stock solution. This part question was not well done. Candidates did not do well in this part question due to fact that they could not realise that the moles in (f) are for 25.0 cm^3 of the stock solution not in 100 cm^3.

(h) This part question was not well done. Candidates did not realise that 3.45 g is the mass of the impure copper compound. They multiplied the number of moles with 3.45 g instead of molar mass of copper (64) and thus they lost a mark.

(i) This part question was well done, calculation of percentage (%) purity was a skill most candidates mastered.

(j) Most candidates at least scored a mark on the names of the solutions that can be used to rinse the burette and pipette during the titration activity.

Answers: (b) 24.1cm^3 **(c)** 0.01205 **(d)** 0.006025 **(e)** 0.006025 **(f)** 0.006025

(g) .0241 **(h)** 1.5424 **(i)** 44.71%

2 This question tested the candidates on qualitative analysis skills. The candidates were provided with solid **R** and liquid **S** which were copper(II) carbonate and ethanol respectively**.** The candidates were requested to give observations and possible tests given some information and conclusions made on the samples. This question was well done by majority of the candidates.

(a) In this part question the candidates were to give the conclusion based on the observation given after dipping both red and blue litmus papers. The mark was highly accessible to majority in the cohort.

(b) (i) The part question was poorly done. Majority of the candidates did not know the purpose of potassium dichromate and therefore centres are encouraged to coach their students on purpose of different substances used for testing especially on common oxidising or reducing agents.

(ii) This part question was fairly done as most candidates scored the mark on exothermic but did not score the mark on the change of colour which is deep green.

(iii) Most candidates scored both marks as they were able to use the conclusion of the substance being acidic to come up with the observation which is blue litmus paper turned red.

(c) The part question was fairly done. Candidates did test for carbon dioxide gas correctly. Candidates that lost the 2 marks had failed to state that the lime water turned milky or bubbles were formed.

(e) (i) The part question was fairly done. Candidates did well and reported the expected observations for copper(II). Other candidates who got the question partly correct did not report on solubility of the substance and as a result only scored two marks out of the possible three.

(ii) The candidates did very well in this part question as they managed to come up with the expected observation when aqueous ammonia is mixed with Cu^{2+} ions solution. Centres are commended for imparting the qualitative analysis skill on their candidates.

(f) This part question was well done as most of the candidates managed to use the conclusions from the table on test of ions to come up with name or formula of solid R, which is copper(II) carbonate.

(g) This part question was well done as majority of the candidates managed to gather the information given in part (a) and (b), and that given in the stem of the question to conclude that liquid **S** is ethanol.

3 This question was on rates of reaction. The candidates displayed lack of knowledge on this subject matter. Candidates performed poorly in this question. Most candidates did not plot the graph as expected.

(a) Rates is all about recording time. Candidates recorded the correct time, those who failed did not report the time to the correct accuracy.

(b) This part question was well done as most of the candidates were able to use the formula given to by calculate the concentration of sodium thiosulphate solution and write the answer in the table.

(c) This part question was fairly done as an average number of candidates were able determine what causes the cross under the flask to disappear and explain that same cause. Therefore, Centres are encouraged to coach learners to read the question not once, so that they understand what is expected, especially on questions that look easier. Most candidates reported yellow precipitate instead of sulphur. This led to loss of marks.

(d) This part question was well done as majority in the cohort managed to deduce the two variables that had been kept constant in the experiment.

(e) This part question was well done as most of the candidates were able to determine the accuracy of the measuring cylinder using the data given in the table.

(f) Centres are encouraged to emphasise the importance of correct orientation and scale on graphs. This part question was poorly done. Candidates who managed to plot the points then failed to draw a line of best fit. Some did not even understand the pattern expected.

(g) This part question was well done. Though most of the candidates could not score all the marks in part (e), they recalled the relationship between the rate of reaction and the concentration, hence, scoring in this part question.

(h) This part question was well done as majority of the candidates were able to determine the source of error that can occur during the experiment.

***Answers*: (a)** 0.000450 moles **(b)** $0.28\,mol/dm^3$

PAPER 5: ALTERNATIVE TO PROVIDER BASED ASSESSMENT PAPER

General Comments

The 2025 Candidates performed fairly on this paper. They did fairly well on writing the topic, aim, research question, hypothesis, presentation of results in a table as well as writing chemical formulae. Despite doing well on these there were other instances where Candidates showed deficiency in presentation of results in a table. The Candidates in some instances stated the quantity but left out the units. Both the quantity and units were required. e.g. volume / cm^3 or time / s. Centres are advised to emphasise that a hypothesis should be relevant and predictive in nature.

There were questions in which Candidates struggled to score marks because the responses given were not sufficient, for example theory or background information, list of materials, interpretation of data and referencing. It was quite surprising to see Candidates failing to give a list of all the apparatus and materials used in titration even though the syllabus covers these in detail. Centres are advised to give attention to this aspect of research project. It is worth noting that candidates did well in aspects such as handling of variables.

There is nothing to report on the apparent change in the performance of the Candidates compared to previous years, since this paper was never administered before. The quality of diagrams was fair. Some Candidates did not label the diagrams while others could not show the proper sequence of their diagrams. Centres are advised to train candidates on knowledge and understanding of separation techniques. Few Candidates failed to observe the rubric as they gave fewer points than what the mark allocation required. Centres should encourage Candidates to observe the mark allocation.

Comments on Individual Items

1 This question on research was fairly done, Candidates were expected to come up with a researchable topic, an aim, theory and methodology. Under methodology the candidates were to give a list of materials and justify their use. They were also expected to write a logical and relevant procedure on the research. Centres are advised to train Candidates on scientific process.

(a) This item was fairly done by majority of candidates. Most candidates were able to come up with a clear, researchable and relevant topic for the investigation. They were able to start their topics with proper verbs such as investigating, finding out, analysing or comparing. Investigating the amount of citric acid in lime and lemon was given as a common correct response. However, some candidates did not mention lime and lemon in their topic and did not score the mark. Centres are therefore advised to give more practise to their candidates on writing clear topics that are relevant to the field of study.

(b) **(i)** This item was well done by most candidates. They were able to correctly write the aim as to investigate or find out or analyse or compare the amount of citric acid in lemon and lime.

(ii) This item was poorly done. Majority of candidates scored one out of the three marks allocated. The mark scheme required them to recognise that citric acid is a weak acid and that it reacts with alkaline solutions such sodium hydroxide to form salt and water. The item required the candidates to know that the concentration of a citric acid can be determined by titration. Some candidates could not score marks because they described methods that could not be used to

determine the amount or concentration of citric acid in the fruits. The common wrong response given by candidates was the measurement of pH (strength) which shows a misconception between strength and concentration. Centres are advised to emphasise on the difference between the two concepts. The candidates failed to explain that the juice which requires a larger volume of sodium hydroxide to reach the end point contains a higher concentration of citric acid.

(iii) This item was well done by majority of candidates. They were able to correctly state the research question as, 'which citrus fruit between lemon and lime has more citric acid?'

(c) (i) This item was poorly done as most candidates scored one out of the three marks allocated. The candidates failed to list the basic apparatus for titration. The question required them to list basic and essential apparatus needed in titration. The question also required that the candidates to justify at least two of the apparatus used. The materials/ reagents required were an indicator, sodium hydroxide, lemon and lime fruit or juice.

(ii) This item was fairly done. The candidates were required to write a titration procedure for lemon juice and repeat it with lime juice. Repeating the titration with another juice showed the ability of candidates to vary the independent variable. The candidates were also required to show ability to measure the dependent variable which is the volume added from the burette and also to handle the control variable (use of pipette volume for both titration of lemon juice and lime juice) and to write a logical and relevant procedure. Some Candidates lost a mark for handling or measuring the dependent variable by failing to measure and record the volume added from the burette. The candidates who wrote methods other than titration were credited for being able to handle the independent variable and the control variable.

2 This question was well done by most candidates. The question required them to show knowledge and understanding on formulae, separation of a soluble salt from an insoluble substance, trends in the melting points, density and physical states of halogens. Candidates showed great understanding of these concepts as they managed to score three out of the four marks allocated.

(a) This item was well answered by most candidates. In particular, almost all candidates were able to write the correct formula of sodium chloride as $NaCl$ and of silicon dioxide as SiO_2.

(b) This item was fairly done by most candidates. Most of the candidates failed to recognise that water should be added to the mixture to dissolve sodium chloride. They also failed to address the purification of the salt by washing it with a little distilled water before drying between two filter papers. The most common responses were filtering the mixture to obtain sodium chloride solution, heat the solution to concentrate or to evaporate excess water cool and allow to crystallise. Candidates who gave the responses such as sieve the mixture, heat to evaporate all the water, wash with water and dry between two filter papers, did not score the intended mark. Centres should note that water is not pure, hence distilled water is required.

(c) This item was poorly done. Candidates failed to recognise that sodium chloride is a salt and therefore, it is a neutral solution with a pH of 7. The common incorrect pH values given by candidates were 8 and 13.

(i) This item was well done by most candidates. Most of the candidates were able to give temperatures above –218 °C and below 35 °C. There was no penalty for omission of units, but those candidates who quoted wrong units lost the mark.

(ii) This item was well done. Most candidates gave density above 3.1028 g/cm^3. There was no penalty for omission of units, but those candidates who quoted wrong units lost the mark.

(iii) This item was fairly done, as most candidates were able to identify the physical state of bromine as solid but in some cases failed to explain that –36 °C is below the melting point of bromine which is –7 °C.

3 This question was fairly done. The question required the candidates to show knowledge and understanding of data presentation and analysis. Most candidates were able to present the results in a table; however, they showed deficiency in interpretation of the results.

(a) This item was fairly done. A reasonable number of candidates were able to give temperature as the independent variable. There were cases where candidates gave temperature as a control variable. A fair number of candidates were able to correctly give volume of nitric acid, concentration of nitric acid, mass of calcium carbonate, surface area of calcium carbonate as control variable. However, there were cases where candidates lost this mark by writing this incorrect response: volume of nitric acid and calcium carbonate without giving a precise volume. Although candidates scored a mark when they gave amount of calcium carbonate as a control variable, they are advised to be specific about the amount which is the mass.

(b) This item was well done. Majority of candidates were able to score three out of the four marks allocated. A significant number of candidates lost a mark on column headings by writing gas produced/ml instead of volume produced/ml. Centres are encouraged to emphasise more on neatness by advising candidates to draw a table using a ruler and ensuring that columns and rows are closed.

(c) This item was fairly done. A reasonable number of candidates gave a predictive and relevant hypothesis, which links an increase in concentration to an increase the rate of the reaction. A fair number of candidates lost this mark by describing the rate of a reaction as being fast or faster instead of being high or higher and vice versa.

(d) This item was poorly done. Most candidates failed to show knowledge and understanding of limitations in science experiments. Majority failed to identify the limitations and explain how they are dealt with. Some Candidates who were able to identify the limitation were unable explain them, hence, did not score a mark.

(e) This item was fairly done. Most candidates were able to state the correct conclusion as increase in temperature increases the rate of reaction. However, it has been noted that interpretation of results was challenging to most candidates. They failed to show comparison in the two

experiments as temperature changed. The most common response that scored was: more gas produced in a shorter time in experiment 2 than in experiment 1. It is still worth noting that candidates described rate as fast instead of high or higher which resulted in the loss of a mark.

(f) This item was poorly done by majority of candidates. Some Candidates failed to state how concentration affects the rate of a reaction before they could give the explanation. Other candidates stated that concentration increases the rate of reaction instead of an increase in concentration increases the rate of the reaction. This was a method mark, hence, most candidates lost all the three marks. In other cases, candidates did not score because they described rate as fast or faster instead of high or increases.

(g) This item was poorly done. Almost all Candidates failed to show knowledge and understanding on referencing. The Candidates included words like at and by in their referencing hence lost the mark. Other Candidates lost the mark because they wrote an incomplete name of the publishing company. In some cases, Candidates wrote the year and place of publication where they are not supposed to be written. Centres are advised to equip candidates by teaching them one recognised referencing style or pattern.