GCSE

Rewarding Learning

Chief Examiner's Report

Chemistry

Summer Series 2019

Foreword

This booklet outlines the performance of candidates in all aspects of this specification for the Summer 2019 series.

CCEA hopes that the Chief Examiner's and/or Principal Moderator's report(s) will be viewed as a helpful and constructive medium to further support teachers and the learning process.

This booklet forms part of the suite of support materials for the specification. Further materials are available from the specification's section on our website at www.ccea.org.uk.

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GCSE CHEMISTRY

Chief Examiner's Report

Subject Overview

- Candidates responded well to the main Unit 1 and 2 papers at higher tier and less well at foundation tier.
- Half equation and ionic equations throughout the papers remain challenging for some candidates but there was evidence of improvement on previous years.
- It should be noted that candidates will be penalised for incorrect symbols or poorly written symbols and also for larger numbers in a formula where subscript ones are required.
- The use of lower case L in the symbol for lithium, e.g. "li_2O" will continue to be penalised.
- Calculations were well answered at higher tier throughout the suite of papers. Foundation candidates struggled with some basic calculation work.
- Excessive rounding within a calculation (for example to 1 significant figure where not appropriate) will be penalised.
- New topics within the specification were mixed in their responses such as water treatment, equilibrium and energy changes in chemical reactions.
- Definitions and commonly used terms will be marked in line with the glossary of terms document which is available on the CCEA website.
- For the new Unit 3, Practical Booklet A was well answered but did give a range of marks.
- Booklet B proved more challenging given its synoptic nature where candidates struggled with questions on test for ions and organic chemistry.
- It should be remembered that Booklet B can address any chemistry throughout the specification.

Assessment Unit 1 Structures, Trends, Chemical Reactions, Quantitative Chemistry and Analysis

Foundation Tier

Unit Overview

- Candidates performed well with balanced symbol equations and atomic structure questions.
- Many struggled with some new parts of the specification such as water treatment.
- Extended writing about the reactivity of the halogens was not well answered.

Q1 Candidates answered both parts of (a) well offering a full definition of the term atom. Some candidates mentioned other subatomic particles in addition to protons and were not awarded the mark. In Part (b)(i), candidates at this level found this section difficult. They were unable to make any meaningful attempt at calculating the M_r of the sample of sulfur using the isotopic abundances. In Part (b)(ii), the meaning of the term isotope is well understood at this level. Candidates were able to work out the number of subatomic particles in the atom but found the same exercise for the negative ion a little more difficult in Part (c).

Q2 Balanced symbol equations for familiar reactions are mainly answered well throughout the suite of papers. Errors were made writing the formula for lithium oxide but students in the main showed a knowledge of the diatomicity of oxygen in Part (a)(i). In Part (a)(ii), foundation tier candidates have a good working knowledge of the formation of an ionic bond between the atoms of a metallic element and the atoms of a non-metallic element. It is possibly a little more difficult to express in words than in pictures but many were awarded the full 6 marks. Some candidates missed marks as they did not complete all aspects of the question. It was rare to see candidates using drawings, which were not awarded marks, as most candidates completed the question as instructed. In Part (a)(iii), most candidates gave the answer, "the electrons are free to move and carry the charge". A small minority realised that the particles concerned were ions. In Parts (b)(i) and (ii), candidates are very good at writing balanced symbol equations for reactions which are familiar to them and can easily identify lone pairs of electrons on bonding diagrams. Candidates are less familiar with the structure of a metal in Part (c). Examiners were awarding marks for a more specific answer than just the word electron.

Q3 Parts (a)(i) to (iv) were from a new part of the specification, the treatment of water to make it potable, but it is unfamiliar to foundation tier students. Examiners did not award the phrase "drinkable water" as a definition of potable, nor the phrase "to purify the water" as the function of chlorine. Although very few candidates were able to attempt an answer to describe a test for chlorine, examiners did not award the mark for damp litmus paper. Candidates were required to name damp blue litmus if this indicator paper was chosen. Only a very small number of candidates were able to recall the function of aluminium sulfate. In Part (b)(i), examiners expected candidates to realise that a measuring cylinder was sufficiently accurate to measure 25 cm^3 of dilute sulfuric acid but did award the mark for more accurate pieces of volumetric apparatus. As in previous years, candidates were awarded marks for recognisable pieces of apparatus which were correctly labelled in the filtration diagram in Part (b)(ii). "Funnel" and "paper" were not awarded marks. Candidates were mostly able to achieve the full 3 marks for this question. In Part (b)(iii), candidates recognised the symbol equation for aluminium oxide and water but found it more difficult to assign the state symbol for aluminium sulfate. In Parts (c)(i) and (ii), the majority of candidates were awarded both the calculation marks. As in previous years, candidates were awarded marks for recognisable pieces of apparatus which were correctly labelled for the diagram of apparatus in Part (c)(iii). Candidates were expected to use an evaporating basin containing the hydrated sample with a wire gauze. However, if the candidate chose to place the sample in a crucible, a pipe clay triangle should have been used. In Part (c)(iv), a small number of candidates did not add 16 × 18 to the M_r. There was evidence that some candidates used atomic number data rather than mass number data.

Q4 Part (a) was well answered by the majority of candidates. In Part (b), many candidates can recall colours of compounds either listed on the specification or using the rule transition metal compounds are usually coloured but they did not realise calcium chloride was dissolved in water and would produce a colourless solution. White was the most common incorrect answer given here. In Part (c), candidates found it difficult to articulate the effect of the error in the chromatography experiment. Some students did not fully understand the difference between the terms effect and error. In Part (d)(i), many of the answers given were more superficial than required. The answer "it contains two colours", or the answer "it is not pure" were not awarded marks. In Part (d)(ii), candidates realised that the measurements were made to the centre of the spot. However, some candidates transposed the calculation and offered an answer > 1. In Part (d)(iii), the vast majority of candidates were able to identify B as the least soluble and marks were also awarded for a correctly stated reason.

Q5 In Part (a), candidates at this level did score some of the marks on this question but it is clear the extended writing questions do pose some difficulty for them. Candidates offered a reactivity series of the halogens but extended it to include fluorine and astatine. Some candidates chose to write balanced symbol equations while the question asked for word equations. In Part (b)(i), many candidates correctly spotted the sulfate ion but others offered chloride ion as an answer. In Part (b)(ii), the vast majority of candidates gave carbon dioxide as the answer. Only those achieving the higher mark ranges on this paper recognised the initial sample as a carbonate. Candidates were largely able to recall that the lilac flame observed during a flame test is due to the presence of potassium ions in the sample.

Higher Tier

Unit Overview

- Writing of state symbols for balanced symbol equations was poorly attempted.
- Candidates struggled with classifying and explaining the structures of different substances and identifying the bond type and particles present.
- Some candidates could not use the number of moles of elements present to write a correct empirical formula.
- Graphene, potable water and the explanation of the reactivity of the halogens were well answered.
- Some candidates do struggle with half equations but this had improved significantly from last year.

Q1 The paper started off in Part (a) with some gentle definition questions which differentiated much more than expected. Many candidates were unable to give an exact definition of the term element and some struggled to correctly identify the type of particle that gives the atomic number. However, even the weakest candidates were able to correctly calculate the relative atomic mass in Part (b)(i) and most recorded the answer correctly to one decimal place. The remainder of Part (b) discriminated very well with only the best candidates understanding that relative was in terms of the carbon-12 isotope and answering in terms of the exact particles present in Part (b)(ii), rather than just citing a definition. An area of weakness was shown in Part (c) in calculating the number of subatomic particles in an ion, though most could calculate the number of subatomic particles in the atom. Determining the empirical formula in Part (d) required working to be shown, and many candidates performed well in calculating the correct number of moles of each element. Some candidates need more practice in converting the number of moles to a formula and unfortunately, writing $2MgSi_4O$ for a formula was a very common error that was penalised.

Q2 In Part (a)(i), many candidates incorrectly gave the formula of lithium oxide as LiO or even Li2O and were penalised. The use of a lower case L as in li_2O should be avoided as this was penalised. Part (b)(ii) was a different type of question, aimed at testing understanding of ionic bonding. In the main, this was well answered, however, many did not include the electronic configurations of the ions produced. A common error was citing the electronic configuration of oxygen as 2,8,6. Coming after the description of ionic bonding perhaps helped candidates with Part (iii) and it was pleasing to note that many realised that it is the ions which move and carry charge to allow conduction. One notable area of improvement on this paper compared with previous years, was that of half equations. Many candidates scored full marks here, and most were able to attempt the question. Covalent bonding in Part (c) was mixed in its presentation. Candidates should note that shells, circles and inner shells are not a requirement and inclusion can lead to errors. The most common error was unpaired lone pairs of electrons in the oxygen atoms or an extra lone pair in the carbon atom. The definition of the term 'allotrope' was answered much better than the definitions in Question 1 (a). A new area on the specification was that of graphite and graphene and candidates were familiar with this in Part (d)(ii), however, often did not answer the question correctly by giving a difference. Part (e)(i) was almost universally correct and many scored at least one mark for the equation in Part (ii). It was disappointing that many candidates were not able to write the correct formula for hydrofluoric acid. The final part of this question was a new style question which tested very effectively candidates' understanding of structure and bonding. One area of concern is that of the covalent molecular compounds, many were unable to identify that fluorine fitted into this category, and only the very best candidates knew that it was van der Waals' forces which were broken on melting. Descriptions of the particles for metallic bonding needed to be exact – positive ions and delocalised electrons.

Q3 Most of Part (a) of this question was very accessible. The emphasis for potable water was on the word 'safe' and the use of chlorine was to kill, not remove bacteria. The test for chlorine was perhaps the question that was most often left blank, or incorrectly answered on this paper. Candidates needed to use damp universal indicator paper for this test. Almost everyone was able to select a piece of apparatus to measure out sulfuric acid, and knew how to remove the excess aluminium oxide by filtering. The equation in Part (b)(iii) was well attempted by most candidates, however, an area of difficulty was in writing state symbols. This is a new area on the specification, and only the best candidates obtained the mark. Many candidates thought that aluminium oxide was aqueous, despite having mentioned how it was separated by filtration in Part (b)(ii). Part (b)(iv) required the answer 'water of crystallisation', however 'degree of hydration' was also accepted. This question discriminated well. Weaker candidates explained the answer to Part (b)(v) in terms of pH but the majority mentioned dissociation into ions which is a marked improvement on previous years. In Part (b)(iv), the effect of decreasing concentration on pH was assessed for the first time, with many candidates obtaining the mark. Most candidates were able to correctly calculate the water of crystallisation, and almost all candidates obtained marks on this question.

Q4 Parts (a) and (b) tested factual knowledge and it was disappointing to note that some candidates did not know that transition metal compounds are coloured, and giving the correct colours of all three compounds was problematic. The rest of this question was on chromatography and it discriminated very well. Many candidates were unable to articulate that the error was in placing the base line below the solvent, and the effect would be that the pigments and dyes would dissolve. Very loose incorrect language such as the dyes would 'run' or 'melt' or 'diffuse' was penalised. In Part (d)(i), a sizeable proportion of the candidature were able to measure the distances moved by the spot and the solvent correctly, though many did not remember the formula for calculating R_f value and obtained an incorrect answer which was greater than one. In Part (d)(ii), a reference to the least distance moved was necessary.

Q5 In Part (a), a new area of the specification on reactivity of the halogens was assessed together with displacement reactions. It was very disappointing to note that many candidates did not give word equations, or gave word equations with the incorrect names, such as iodide for iodine and bromide for bromine. Symbol equations were not accepted as the examination team were assessing use of names of chemicals. The order of reactivity was usually given correctly and most candidates had a good grasp of the idea that this was to do with the size of the atom and the attraction of the nucleus for incoming electrons, although sometimes the terminology used was confused. Weaker candidates also expressed an argument in terms of loss of an electron, which was incorrect. Analysis of the tests in Part (b) to identify the ion present was problematic. Many candidates did not give the correct formula of the anion or cation. Despite these being given on the Data Leaflet, many candidates wrote incorrect formula or failed to give the charge.

Assessment Unit 2 Further Chemical Reactions, Rates and Equilibrium, Calculations and Organic Chemistry

Foundation Tier

Unit Overview

- Candidates responded well to the equations for the production of carbon monoxide in the Blast Furnace.
- The answer "energy is required to form bonds" was a common error.
- Candidates did not respond well to the cracking equation in Question 3.
- The full chemical name of rust was not well recalled.
- Omissions or incomplete answers were common in the reason for the choice of the material for the electrodes in Question 5.
- The percentage composition of air was poorly recalled in Question 6.

Q1 In Part (a)(i), candidates did not seem to know the name of the ore of iron. Many offered the answer "iron ore". Candidates were able to state the names of the raw materials used in the Blast Furnace, although only hot air was awarded rather than air or oxygen in Part (a)(ii). In Part (b)(i), the two equations for the production of carbon monoxide were well known by the majority of the candidates. Candidates were mostly able to balance the equation for the reduction of iron ore in Part (b)(ii). Many candidates were able to correctly define oxidation and reduction in terms of oxygen content in Part (b)(iii), although some offered all three definitions based on oxygen, hydrogen and electrons. Marks were not awarded for answers of the style "iron ore lost oxygen which is oxidation".

Q2 Most candidates gave a definition of the chemical term 'catalyst' rather than an answer on how the catalyst worked in Part (a)(i). Reaction pathway was required rather than just pathway. In Part (a)(ii), candidates were able to achieve both marks here. Part (b) was answered well by the majority of candidates. All candidates were able to follow the instruction to enter a tick (✓) symbol. In Part (c)(i), some candidates misunderstood the question and gave an answer based on equilibrium principles. Some candidates stated that energy was required both to break bonds

and to make bonds. The majority of candidates were able to calculate the energy required to break the bonds and the energy released when the bonds were made, but calculated the energy as 92 KJ rather than -92 KJ in Part (c)(ii). The use of a specific sign is important. This is reflected in the distribution of marks. The idea that the energy change of the forward reaction is equal to the numerical value of the energy change of the backward reaction, and that if the forward reaction is exothermic then the backward reaction is endothermic, is not well known at this level in Part (c)(iii).

Q3 The definition in Part (a)(i) was well known by candidates but many candidates incorrectly gave the general formula of the alkanes or the formula of ethene in Part (a)(ii). In Part (b), candidates showed an excellent grasp of writing balanced symbol equations which are familiar to them throughout the suite of papers. Most candidates were able to achieve the first two marking points, realising that oxygen is a diatomic molecule. In Part (c)(i), the first mark was awarded for realising that there was only one reactant, "C_7H_{16} →". Many of the candidates working at this level added oxygen or hydrogen to the reactant and produced water and carbon dioxide. In Part (c)(ii), a very small number of candidates were able to work out the molecule and its name. Part (c)(iii), was well answered with candidates understanding that the high temperatures were required to break the strong bonds within the molecule. In Part (d), many of the candidates were able to score 4 marks or more in this QwC question. The highly structured nature of the question suited the candidature.

Q4 A variety of spellings of the name of the indicator were accepted in Part (a)(i). In Part (a)(ii), pipette was the answer in the context of the question but burette was also accepted. As the measurement was given to one decimal place, beaker and measuring cylinder were not accepted. Candidates were able to state the mathematical formula for atom economy but many had difficulty working out the total mass of atoms, not realising 2 x 18 was the contribution of the water in Part (a)(iii). Candidates were required to work out at least one M_r correctly to be awarded an Error Carried Forward (ECF) mark for the atom economy. There was some evidence of a small minority of candidates using atomic numbers rather than mass numbers. In Part (b)(i), the rusting experiment is well understood by candidates. Almost all were able to state that rust would be visible on the nail in Test tube 1. In Parts (b)(ii) and (iii), the majority of candidates understood the function of the oil in Test tube 2 but many failed to appreciate the use of the drying agent in Test tube 3. Listing was not accepted, for example: "The anhydrous calcium chloride absorbs water and air/ oxygen". In Parts (b)(iv) and (v), candidates can describe the appearance of rust but fail to remember the full chemical name of the compound. For Part (b)(vi), most candidates were awarded this mark.

Q5 In Part (a), some candidates were able to state a full and comprehensive definition of electrolysis, while others had a vague idea of the use of electricity in the process. Graphite was expected for the answer to Part (b)(i), however, the vast majority of candidates gave the names of a range of metals, including lead. The mark in Part (b)(ii) was awarded for the idea that graphite is a good conductor of electricity, not just conductor or conductor of electricity. As Part (b)(iii) referred to a specific reaction, the name of one of the products of the reaction was required to be linked to the word 'toxic' before awarding the mark. In Part (b)(iv), candidates find it difficult to assign the correct name to each electrode, although more than half the candidature was awarded this mark. In Part (c), the majority of candidates were able name the products of the electrolysis with only a very small minority using the name bromide. However, the products of electrolysis were often assigned to the incorrect electrode. The possible observations that can be made were very poorly answered.

Q6 The vast majority of the candidature were able to state that oxygen is a colourless gas in Part (a)(i). Very few candidates used the word clear, for which there was no credit given. The uses of oxygen gas were not correctly understood in Part (a)(ii). It is clear that candidates have had an opportunity to burn samples of magnesium in Part (b), but it was rare to see a script where the marks for the observations made on heating sulfur were awarded. Most candidates were aware that metal oxides are basic. In Parts (c)(i) and (ii), candidates were, in the main, unable to recall the percentage of nitrogen in the air or why nitrogen is a very unreactive gas. Most of the candidature stated the lack of reactivity of nitrogen was due to the fact that "it", taken to mean the atoms in the molecule, had a full outer shell of electrons. In Part (c)(iii), the vast majority of candidates believe that hydrogen is present in the air. The names of pollutant gases were not accepted here.

Higher Tier

Unit Overview

- The name of the reducing agent in the blast furnace was not widely known.
- Many candidates do not fully understand the meaning of dynamic equilibrium nor the effect of changing pressure on the position of equilibrium.
- The description of an exothermic reaction in terms of bonds broken and made often yielded the incorrect statement: "energy required to form bonds".
- Calculation of the energy change from given bond energies was incorrect in a large number of scripts.
- The structural formulae of but-1-ene and but-2-ene were not well known, nor was the name of the monomer chloroethene.
- The balanced symbol equation for the cracking of C_7H_{16} was very poorly answered.
- Additional polymerisation was a common incorrect answer for the type of polymerisation of ethene.
- Avogadro's Law was not well known and gas volume calculations were poorly answered.
- Clear working out should be shown in quantitative questions.

Q1 In Part (a)(i), the name of the ore from which iron is extracted was widely known although bauxite did appear quite often. In Part (a)(ii), the meaning of redox was well answered. The name of the reducing agent in the Blast Furnace produced a variety of answers in Part (b)(i) and incorrect answers then resulted in marks also being lost in the subsequent balanced symbol equations. The balanced equation for the reduction of iron ore in Part (b)(ii) proved challenging for many candidates. The process of phytomining was well known by many candidates in Part (c)(i), although marks were lost in Part (c)(ii) for not giving a comparative when asked why iron can displace copper from the solution. The half-equation in Part (c)(iii) was correctly written by many candidates and it is pleasing to note an improvement in the writing of half-equations since last year. An advantage of phytomining was required in Part (c)(iv) and many candidates gave incorrect answers, including it is less expensive or more eco-friendly.

Q2 In Part (a), many candidates described what a catalyst is instead of explaining how a catalyst works. The meaning of dynamic equilibrium was not well known in Part (b)(i), with many stating the forward reaction is the same as the backward reaction with no mention of rate of reaction. Also, a common error was to state that the concentration of reactants and products stay the same instead of remains constant. In Part (b)(ii), the question asked for the effect of increasing temperature on rate of the reaction but many candidates referred to the effect on the position of equilibrium instead of rate of reaction. In Part (b)(iii), candidates were asked to use Le Châtelier's Principle to state and explain the effect of increasing the pressure on the yield of ammonia at constant temperature – this concept was not widely understood and only the best candidates scored full marks. Candidates were asked to explain, in terms of bonds, why the Haber Process was exothermic in Part (c)(i); a common incorrect statement was 'energy is required to make bonds'. Also, many candidates failed to name the reactants and products which was penalised. The completion of the reaction profile diagram in Part (c)(ii) was well performed by many candidates. However, the calculation of the energy change from given bond energies was not well answered in Part (c)(iii), with common errors being multiplying the energy required to break the reactant bonds by 2 and giving the wrong sign in the final answer.

Q3 Parts (a)(i) and (ii) were very well answered with the vast majority being able to state the meaning of the term 'hydrocarbon' and write the general formula of the alkenes. Part (b)(i) asked for the structures of but-1-ene and but-2-ene and many candidates struggled with this; structures with carbon forming 3 or 5 covalent bonds were common. The balanced symbol equation in Part (b)(ii) was well answered. In Part (c)(i), the balanced symbol equation for the cracking of C_7H_{16} was very poorly written with many candidates incorrectly including O_2 as a reactant and this was penalised. Consequently, Part (c)(ii) was not well answered and in Part (c)(iii), candidates were asked to suggest why high temperatures are required for cracking which proved challenging even for some of the very able candidates. Polymerisation was examined in Part (d) and yet again 'additional' appeared instead of addition much too often in Part (d)(i). The name of the monomer, chloroethene, in Part (d)(ii) was poorly answered with the most common incorrect answers being ethene, polyvinylchloride or chlorethene. The equation for the polymerisation of ethene was quite well answered in Part (d)(iii). The QwC question in Part (d) examined the chemical test for alkenes and was well answered with many candidates scoring 4 marks out of 6 marks available. The symbol equation for the reaction between ethene and bromine was not well known which resulted in the loss of 2 marks.

Q4 The titration question in Part (a)(i) was well answered with many candidates benefiting from Error Carried Forward (ECF) marks in this and subsequent calculations. However, the conversion of the concentration from mol/dm^3 to g/dm^3 in Part (a)(ii) proved challenging for many candidates. The gas volume calculation in Part (b) was poorly answered with many failing to convert from Kg to g or doing so incorrectly; calculating the M_r of calcium nitrate incorrectly or failing to use the correct mole ratio. In addition, many candidates multiplied the calculated moles of gas by the M_r instead of 24 dm^3. Avogadro's Law was not widely known in Part (c)(i). Part (c)(ii) was subsequently poorly answered as candidates failed to apply Avogadro's Law.

Q5 In Part (a), the meaning of the term electrolysis was widely known. Many candidates correctly identified graphite as the material used to make the electrodes in Part (b)(i) and also were able to give two reasons why graphite is used. Some candidates continue to state 'cheap' as a reason which is not acceptable and care should be taken to state 'good conductor of electricity' and not just that it conducts. Many candidates lost the mark in Part (b)(iii) for failing to state the name of the toxic product(s) or stating the products were harmful or dangerous rather than toxic. The

name of the positive electrode was very well answered in Part (b)(iv). In Part (c), many candidates scored highly and it was pleasing to see an improvement in candidates' ability to write correct half-equations.

Q6 The balanced symbol equation for the decomposition of hydrogen peroxide in Part (a)(i) was well answered however, the formula of the catalyst used in this reaction was perhaps the least well answered question on this paper. The chemical test for oxygen gas was successfully answered with very few candidates scoring zero marks. Part (b) examined the reaction of oxygen gas with magnesium and sulfur. The magnesium reaction was answered better with many candidates scoring full marks. The sulfur reaction was not well known, with many incorrect observations being given and the appearance of the product being described incorrectly as a solid. The nature of the two oxides was very well answered.

Assessment Unit 3 Practical Skills

Booklet A Foundation Tier

Unit Overview

- Candidates responded well to the practical tasks set and provided answers worthy of many of the marks.
- Some omissions in observations and description of the appearance of the substances used did lose marks.
- Units were not always used consistently.
- Errors occurred in recording numerical data in tables and to a consistent number of decimal places.
- Some candidates did include the rough titre in their calculation of the average titre and units were often missing.

Q1 For Questions 1 (a)(i) to (b)(i), all of the candidates correctly recorded their observations for these sections. In Part (b)(ii), a very small number of candidates were not awarded full marks for filling in the table as they used the units throughout despite the unit being present in the column heading. Candidates were expected to record all of the measurements of mass to the same number of decimal places. Only a very small number of candidates failed to gain the full two marks in Part (b)(iii), usually as they had omitted the unit or used an incorrect unit. It should be noted that "grams" was not accepted as "g" was given in the table.

Q2 Only a very small number of candidates failed to gain the full two marks in Part (a), usually as they had omitted the unit. A very small number of candidates were not awarded full marks for recording the titration results in the table provided in Part (b). There were, however, a number of different errors noted by the examiners:

- Units used throughout despite the unit being present in the column heading.
- Not all readings recorded to the same number of decimal places.
- Initial reading on the burette recorded as 50/50.0 cm^3.
- The rough titre being less than the two accurate titres.
- Accurate titres being more than 0.2 cm^3 apart.

In Part (b)(ii), a few candidates used the rough value to calculate an average titre. Otherwise, this question was well executed by the candidature. In Part (b)(iii), very few candidates were not awarded this mark for the colour change of the indicator. "Clear" was not awarded for "colourless".

Booklet B Foundation Tier

Unit Overview

- Candidates confused a burette with a pipette in Question 1 and although asked about the pipette, they would extend their answer to discuss the titration.
- Accuracy answers for the titration were not forthcoming from the candidature.
- Many candidates were not able to identify the cation or anion in Question 2 and the description of the flame test and sulfate ion test lacked sufficient detail.
- Question 3 was well answered with many gaining most of the marks in this rates of reaction question.
- The evidence for the reaction being exothermic was poorly expressed in Question 4, as were the names of the products of the displacement reaction with "copper(II)" being a common error.
- Question 5 on gas chemistry was well answered in general, although some did not know the term 'gas jar' or were not able to explain why the gas was collected over water.

Q1 Many Foundation Tier candidates showed a familiarisation with the technique, giving practical details in Part (a), but some used the word 'pipette' while clearly speaking about the burette. A few candidates extended their answer to speak about the preparation of the burette and the subsequent titration.

In Parts (b) and (c)(i), candidates were awarded very few marks for stating ways in which the end-point is determined accurately. There was evidence from the extended answers to Part (a) that they knew to swirl the flask and carry out a rough titration, but the understanding of why they were asked to do this as part of titration technique was lacking. Most candidates were able to correctly state the initial colour of methyl orange in the alkali as yellow but many stated colourless or pink for the colour at the end point in Part (c)(ii). Candidates were awarded the first mark for the word equation but made one or two errors and subsequently, a lower number of candidates gained the second mark. Candidates gave the name of the salt as sulfide or omitted water as a product.

Q2 For Parts (a)(i) to (iii), the vast majority of candidates at this level identified the cation as Mg^{2+} rather than Zn^{2+} and the anion as Cl^{-} rather than Br^{-}. In Part (a)(iv), a very small number of candidates understood that the white precipitate formed in test 4 was a hydroxide. Candidates often missed out on details required and were not awarded a mark in Part (b)(i), for example, the acid used must be concentrated hydrochloric acid and the flame used must be a blue Bunsen burner flame.
In Part (b)(ii), many candidates realised the solid should be dissolved in water but did not recall the name of the reagent but went on to recall the presence of a white precipitate.

Q3 Candidates mainly drew labelled recognisable pieces of apparatus in Part (a)(i). As the mark scheme stated a maximum four marks for five marking points, a large number of candidates gained the full four marks even if the conical flask was not sealed or they had omitted a stop clock. In Part (a)(ii), candidates made excellent attempts at writing balanced symbol equations for familiar reactions. For Part (b), the entirety of this part of question 3 was well answered by candidates. They can read information from a graph accurately. Some candidates lost the mark for omitting the unit.

Q4 For Parts (a)(i) and (i), the vast majority of the candidature were awarded both the marks. In Part (a)(iii), candidates found it difficult to express that the temperature increased in the reaction. They offered long explanations of an exothermic reaction. Part (a)(iv) was well answered, however, mass of metal was not accepted. Candidates made a reasonable attempt at the balanced symbol equation in Part (a)(v). In Part (b)(i), candidates read and understood the reactivity data given in the table. Most were awarded two marks. It was rare to see a script where the candidate did not gain at least one mark. In Part (b)(ii), candidates were able to name the products but copper(II) was a common mistake. The formula of chromium nitrate proved a little more problematic in Part (b)(iii).

Q5 In Part (a)(i), the vast majority of candidates cannot name a gas jar. Glass jar, gas chamber and gas tube were common incorrect answers. Many candidates were able to convey the idea that this prevents the gas from escaping through the thistle funnel in Part (a)(ii). In Part (a)(iii), a very small minority realised that oxygen gas can be collected in this way because it is not very soluble in water. Many candidates gave answers that compared the density of oxygen to the density of water. Candidates were able to balance the equation but were unable to infer from the labels given in the diagram (hydrogen peroxide solution) that the state symbol for H_2O_2 was (aq) in Part (a)(iv). Candidates can give a full definition of a catalyst and were very familiar with the test for oxygen gas. In Part (b), the test for ammonia gas has proven difficult in the past for many candidates and responses were given to choose from this year which proved more successful. For Parts (c)(i) to (iv), the questions were accessible to the vast majority of Foundation Tier candidates.

Booklet A Higher Tier

Unit Overview

- Candidates performed well in this practical task with some marks being lost for incomplete or inaccurate observations or for the descriptions of the appearance of the substances being used.
- Candidates were successful at recording in tabular form, however, marks were lost for units being included or inconsistencies in the number of decimal places in both Questions 1 and 2.
- Some candidates did record the initial burette reading as 50.0 cm^3 in the table.
- Average titre calculations did sometimes include the rough titre.
- Candidates were instructed to carry out a rough titration and two accurate titrations so any additional titrations were not marked.

Q1 In Part (a)(i), most candidates gained the marks for the correct description of the appearance of hydrochloric acid. The temperature had to be recorded with °C as the unit in Part (a)(ii) to gain the mark. The appearance of the magnesium ribbon in Part (a)(iii) allowed most candidates to gain the two marks but some did lose one mark for using the terms ‘strip’ or ‘band’ rather than solid. However, these terms were ignored if solid was also present. In Part (a)(iv), most candidates gained at least 2 marks with the lost mark most often being for “magnesium dissolves” or “heat is released” which was stated in the question. These were again ignored if correct observations were present. In Part (b)(i), most candidates gained the marks for the appearance of the marble chips but again “solid” was sometimes omitted with rocks and lumps being common answers. In Part (b)(ii), candidates were asked to record the mass values in the table as the marble chips reacted with the hydrochloric acid. It was obvious that some candidates had tared the balance before adding the marble chips and this was not penalised. Common penalties were for not showing a decrease in mass

throughout and putting the unit (g) in the table with the values. It was also expected that all values be recorded to the same number of decimal places. In Part (b)(iii), some candidates lost the marks for incorrect or missing units. It should be noted that "grams" was not accepted, only "g" as the unit as this was given in the table. The loss in mass should not be recorded as a negative number.

Q2 Most candidates gained the two marks in Part (a) for the maximum volume which could be measured using the burette. The use of "ml" in place of "cm^3" was relatively common and was accepted. The headings in the titration table in Part (b)(i) were expected to be "initial burette reading /cm^3", "final burette reading/cm^3" and "titre / cm^3". Candidates lost marks for incorrect headings or omitting units. A solidus or brackets were accepted to separate the quantity from the units. When recording titration results in Part (b)(ii), the most common errors were:

- Units used throughout despite the unit being present in the column heading.
- Not all readings recorded to the same number of decimal places.
- Initial burette reading recorded as 50/50.0 cm^3.
- The rough titre being less than the two accurate titres.
- Accurate titres being more than 0.2 cm^3 apart.

Some candidates did present more than two accurate titrations but only the two accurate titrations expected in the table were marked as per the instructions. Most candidates gained two marks for the calculation of the average titre in Part (b)(iii), though some candidates did include the rough titre value or failed to present units with the value given. The colour change was almost always correct in Part (b)(iv) with "clear" being given for "colourless" by a few candidates and this was penalised.

Booklet B Higher Tier

Unit Overview

- Accuracy details in the titration were often omitted.
- Colour change with methyl orange produced a variety of responses, including those of phenolphthalein.
- Calculation work in the paper was generally well presented but conversion between mol/dm^3 and g/dm^3 was poorly answered.
- Candidates struggled to identify ions from given tests and observations and very few candidates could write an ionic equation or identify the precipitate in an ion test.
- The use of limewater was not well described with many candidates bubbling the solution through limewater.
- Some candidates struggled with the concept of working back in the calculation from the mass of gas to the percentage of calcium carbonate, with the ratio (even though 1:1) being a common issue.
- The evidence for the reaction being exothermic was poorly expressed in Question 4, as were the names of the products of the displacement reaction, with "copper(II)" being a common error.
- The products of the displacement reaction between copper(II) nitrate and cobalt sometimes incorrectly highlighted "copper(II)" as a product.
- Many candidates struggled with the organic chemistry in Question 5, especially Parts (a) and (c).

Q1 In Part (a), many candidates scored full marks in this QwC question. Marks were lost for failing to include swirling the conical flask or ensuring the jet was filled/no air bubbles. In Part (b)(i), many candidates referred to improving accuracy of subsequent titrations which was not acceptable. The colour change was reasonably well answered in Part (b)(ii) but many candidates used pink and colourless or confused the order of the colours for methyl orange. In Parts (b)(iii) – (vi), the majority scored full marks in this calculation or benefitted from Error Carried Forward. Many candidates did not know how to convert between mol/dm^3 and g/dm^3 in Part (b)(iv) with × 1000 being a common error.

Q2 Overall, this was a very poorly answered question on tests for ions. Many candidates stated Mg^{2+} as the cation and the anion was not known, with many giving Cl^- or Br^{2-}. The ionic equation in Part (a)(iv) was again poorly answered with only the top candidates writing it correctly and the name of the precipitate was answered correctly by only a very small number of candidates. Many candidates scored full marks in Part (b)(i), giving flame test and lilac flame. In Part (b)(ii), marks were lost for failing to give observations when acid was added to the solid i.e. fizzing/gas produced/ effervescence. Many described "bubbling the solution through limewater" rather than the gas and this was also penalised. Colourless to milky was required for the final mark. Cloudy was accepted for milky but should be avoided as it does not imply white.

Q3 The diagram in Part (a) was well drawn with many candidates scoring full marks. Sealed apparatus diagrams were penalised and other errors included not drawing a labelled stop clock, not drawing a recognisable conical flask and not naming the balance correctly. In Part (b)(i), many candidates lost the mark for stating the marble chip had all reacted. The graph was drawn correctly by the vast majority in Part (b)(ii), though some candidates did draw it above the given curve. The mass loss in Part (c)(i) was calculated correctly by many candidates although some omitted units which were essential. Subsequent calculations in Parts (ii) – (v) were also answered correctly and candidates benefitted from Error Carried Forward, though any percentage above 100% or calculation of the percentage by inverting the numbers was not credited. The percentage was sometimes not given to 1 decimal place as instructed and this was also penalised.

Q4 Almost all candidates scored full marks in Part (a)(i) and the vast majority were able to place tin correctly in the reactivity series in Part (a)(ii). In Part (a)(iii), candidates lost marks for failing to state that the temperature increased - many stated that heat was given out with no mention of temperature. In Part (a)(iv), the most common incorrect answer was 'mass of metal' – many candidates scored 1 mark out of the 2 available marks. The equation in Part (a)(v) was well written by many candidates but errors in the formula of nitric acid were common, such as "H_2NO_3". In Part (b)(i), the correct statements of comparative reactivity were correctly identified by most candidates and the names of the products were well known in Part (b)(ii), with copper(II) being a common incorrect answer. It was very pleasing to see a large number of candidates writing the balanced symbol equation for the reaction between chromium and iron(II) nitrate correctly.

Q5 In Parts (a)(i) – (iv), many candidates lost marks for giving the name of the homologous series instead of the functional group. Very few candidates used the terms hydroxyl and carboxyl. In Part (a)(v), the names and structures of propan-1-ol and propan-2-ol were known by only the most able candidates. Many candidates gave the names as prop-1-anol and prop-2-anol and drew structures containing double C=C bonds or C atoms with fewer than 4 covalent bonds formed. The definition of a weak acid was well known in Part (b)(i), although quite a few candidates talked about the hydrogens being partially ionised. In Part (b)(ii), many

candidates referred to a chemical reaction being used to distinguish between a strong and a weak acid, most commonly, the reaction with magnesium metal. Most of the candidates who used universal indicator or a pH meter scored full marks. The name of the salt in Part (c)(i) was well known although quite a few candidates omitted the 'o' and called it "sodium propanate". The colour change in Part (c)(ii) was not well known with many candidates quoting blue-green or green instead of blue. The balanced symbol equation in Part (c)(iii) proved very challenging for many, with only the most able candidates scoring full marks.

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