



GCE Examiners' Report

Chemistry
AS and A Level
Summer 2024

Introduction

Our Principal Examiners' report provides valuable feedback on the recent assessment series. It has been written by our Principal Examiners and Principal Moderators after the completion of marking and moderation, and details how candidates have performed in each unit.

This report opens with a summary of candidates' performance, including the assessment objectives/skills/topics/themes being tested, and highlights the characteristics of successful performance and where performance could be improved. It then looks in detail at each unit, pinpointing aspects that proved challenging to some candidates and suggesting some reasons as to why that might be.¹

The information found in this report provides valuable insight for practitioners to support their teaching and learning activity. We would also encourage practitioners to share this document – in its entirety or in part – with their learners to help with exam preparation, to understand how to avoid pitfalls and to add to their revision toolbox.

Further support

Document	Description	Link
Professional Learning / CPD	WJEC offers an extensive programme of online and face-to-face Professional Learning events. Access interactive feedback, review example candidate responses, gain practical ideas for the classroom and put questions to our dedicated team by registering for one of our events here.	https://www.wjec.co.uk/home/professional-learning/
Past papers	Access the bank of past papers for this qualification, including the most recent assessments. Please note that we do not make past papers available on the public website until 12 months after the examination.	Portal by WJEC or on the WJEC subject page
Grade boundary information	Grade boundaries are the minimum number of marks needed to achieve each grade. For unitised specifications grade boundaries are expressed on a Uniform Mark Scale (UMS). UMS grade boundaries remain the same every year as the range of UMS mark percentages allocated to a particular grade does not change. UMS grade boundaries are published at overall subject and unit level. For linear specifications, a single grade is awarded for the subject, rather than for each unit that contributes towards the overall grade. Grade boundaries are published on results day.	For unitised specifications click here: Results, Grade Boundaries and PRS (wjec.co.uk)

¹ Please note that where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

Exam Results Analysis	WJEC provides information to examination centres via the WJEC Portal. This is restricted to centre staff only. Access is granted to centre staff by the Examinations Officer at the centre.	Portal by WJEC
Classroom Resources	Access our extensive range of FREE classroom resources, including blended learning materials, exam walk-throughs and knowledge organisers to support teaching and learning.	https://resources.wjec.co.uk/
Bank of Professional Learning materials	Access our bank of Professional Learning materials from previous events from our secure website and additional pre-recorded materials available in the public domain.	Portal by WJEC or on the WJEC subject page.
Become an examiner with WJEC.	We are always looking to recruit new examiners or moderators. These opportunities can provide you with valuable insight into the assessment process, enhance your skill set, increase your understanding of your subject and inform your teaching.	Become an Examiner WJEC

Contents

	Page
Executive summary	5
Unit 1 – The Language of Chemistry, Structure of Matter and Simple Reactions	7
Unit 2 – Energy, Rate and Chemistry of Carbon Compounds	11
Unit 3 – Physical and Inorganic Chemistry	17
Unit 4 – Organic Chemistry and Analysis	20
Unit 5 – Experimental Task	23
Unit 5 – Practical Methods and Analysis Task	25
Supporting you – useful contacts and links	28

Executive Summary

There were in the region of 4000 entries for the AS papers this year and around 2200 candidates cashing-in the A level. Mean marks on the A2 papers were higher than those on the AS papers. Performance was generally quite pleasing with some exceptional work seen from the best candidates.

The majority of candidates on AS papers showed basic knowledge of some parts of the specification but there were often significant gaps in other areas. They showed good mathematical skills in familiar calculations but often struggled when asked to use those skills in an unfamiliar situation. It was common to see equations rearranged incorrectly and values substituted without conversion to the correct units.

Knowledge of practical methods was quite disappointing and often suggested a lack of first-hand experience of common laboratory work on thermochemistry and rate. When drawing conclusions from given qualitative data, marks were often lost for not directly linking inferences to the relevant data.

Candidates sitting A2 papers showed a good breadth of specification knowledge with fewer significant gaps than those at AS. Application of knowledge in familiar contexts was usually good and the best candidates showed the depth of understanding needed to bring different ideas together in complex questions.

Good practical skills were demonstrated in the Experimental Task where the majority performed very well although some candidates from across the ability range lost marks carelessly in recording and processing the data collected. Familiar calculations were again well done and whilst there was better application in unfamiliar contexts than seen at AS there were lots of examples of errors in the conversion of units.

One final point relevant across all units is the need to ensure that the appropriate level of detail is included in answers. Simple statements will not gain full credit in questions which ask for an explanation. Candidates should consider the command word used in the question, the number of marks available and the amount of space included for the answer in judging whether a few words, a single sentence or a few sentences are needed in a complete response.

Almost all candidates showed a degree of positive achievement and it was pleasing to see grade boundaries at levels similar to those seen from 2017-19. Candidates and centres should reflect positively on this performance before targeting the highlighted areas for improvement.

Areas for improvement	Classroom resources	Brief description of resource
Conversion of units	Chemistry - Educational Resources - WJEC Knowledge organisers Chemical calculations (ii) Chemical kinetics	Knowledge organisers give a high-level summary of key knowledge and skills required within each specification topic, including exemplar calculations in the case of these two presentations
	Question Bank by WJEC	Question Bank is a searchable past paper resource where keywords can be searched to find questions on topics that require conversion of units e.g. use of $pV = nRT$ and the Arrhenius equation
Understanding of practical methods	Chemistry Experiments on Film (science.cymru)	Experiments on Film is a video resource designed to complement the hands-on practical work
Level of detail required (and other aspects of exam technique)	Chemistry - Educational Resources - WJEC	Exam walk-through presentations based on the summer 2019 papers; focus on key information given in questions, command words, approaches to answering particular types of questions and much more

CHEMISTRY

GCE

Summer 2024

UNIT 1 – THE LANGUAGE OF CHEMISTRY, STRUCTURE OF MATTER AND SIMPLE REACTIONS

Overview of the Unit

The number of entries was 3915 which is around 350 higher than last year and the same as in 2019. The mean mark was 37.8 which is 8.3 up from last year. Performance across all questions was very similar but question 11 was the least well answered in Section B.

It was pleasing to note that good knowledge of electron configuration, balancing equations and ionic bond formation was shown by many candidates. Most candidates also showed a fair knowledge of radioactivity and bond angles in molecules. There was also an improvement in ionic equation writing with Q9(b)(i) being fairly well answered. However, as noted in previous reports, the examiners were disappointed with the standard of answers to some questions, including the QER question (Q12a). Too many marks are still lost for basic knowledge and application e.g. Q6(a) (number of neutrons in a species), Q9(a)(i) (structure of diamond and graphite), Q12(b)(i) (expression for K_c). The mass spectrum question (Q10(b)) was poorly answered.

Many candidates performed well in some familiar calculation questions e.g. Q10(c)(i) (pH), Q12(b)(ii) (equilibrium constant), Q12(c)(i) (atom economy). However, calculations that were slightly different were poorly answered e.g. Q7 (moles of atoms in a compound), Q13(e)(i)&(ii) (double titration calculation). Generally, candidates' understanding of numerical concepts is still lacking in depth and many still have difficulty in converting from one unit of measurement to another and in changing the subject of a formula.

Comments on individual questions/sections

SECTION A

This section was fairly well answered with the mean mark being around 5.8 out of 10.

Questions 1, 2, 3, 4 and 5 were well answered. Questions 6 and 8 were fairly well answered and question 7 was very poorly answered.

In Q6(a) the candidates had to work out the number of neutrons in an atom and an ion and in Q6(b) they had to work out the number of electrons in an atom and an ion. Around a half gave a correct answer to both parts. The ${}_{16}^{32}\text{S}^{2-}$ ion caused the problem. In part (a) the main error was to suggest that charge changes the number of neutrons, with both 18 and 14 seen commonly. In part (b) the main error was to ignore the effects of charge, giving an answer of 16 instead of 18.

In Q8 just under half gained both marks. The main error for candidates using $n = \frac{V}{V_m}$ was using an incorrect value for V_m . Those using $pV = nRT$ often failed to convert atm to Pa or rearranged the equation incorrectly.

Fewer than 10% gave a correct answer to Q7. The candidates were asked to find the number of moles of oxygen atoms in a compound. This type of calculation has not been set for a long time and the vast majority did not know what to do. They did not realise that the formula of a compound represents one mole of that compound. Most assumed that because 'atoms' had been asked for they had to use the Avogadro constant.

SECTION B

For this section the feedback is arranged according to the following skills and themes:

- Important concepts (ionisation energy, bonding and solid structures, equilibrium)
- Mathematical skills
- Practical aspects

Important concepts

Ionisation energy

This was tested in Q11 parts (a) and (b)(i). Part (a)(i) was well answered, part (b)(i) was fairly well answered but part (a)(ii) was very poorly answered.

In (a)(i) two thirds explained how the graph showed that element X was in Group 2. A significant minority lost the mark for stating 'increase' or 'jump' instead of 'large increase'. In (b)(i) many lost the mark for omitting state symbols or giving them incorrectly.

In (a)(ii) only a small number scored all three marks and about two thirds failed to score any mark. The main errors were:

- giving the pattern in first ionisation energy across a period without any explanation
- stating that element X had a higher ionisation energy than element Y because of an increase in electrons instead of protons
- stating that element X had extra stability due to a full sub-shell of electrons
- stating that element Z's outer electron was in a new orbital without any explanation

Bonding and solid structures

Q9(a)(i) tested the candidates' knowledge of diamond and graphite. The first part was simple recall where candidates only had to describe the structure and bonding but it was disappointingly answered. The main errors were:

- omitting reference to the tetrahedral shape for diamond
- just stating 'bonds' instead of 'covalent bonds'

In the second part they had to compare properties and explain them in terms of structure and bonding. This was better done with around half scoring at least three out of four. The main errors were:

- giving 'lubricant' as a *property* of graphite
- explaining graphite's conductivity in terms of weak bonds between layers
- explaining high melting temperature in terms of strong intermolecular bonding

The dot and cross diagram in Q9(a)(ii) was straightforward and most candidates gained both marks. Some lost marks for giving incorrect charges on the ions or showing covalent bonding rather than ionic bonding. However, the part about the crystal structure was very poorly answered. A minority lost the mark for stating 'atom' or 'molecule' instead of 'ion', but most misunderstood the question and simply gave the coordination numbers of the ions.

Q11(c) was about bond angles and VSEPR theory. Although the vast majority scored at least one mark, it was just simple recall and disappointingly fewer than half the candidates managed to give all three bond angles correctly. In part (ii) candidates had to explain why bond angles do not rely solely on the number of bonds and to give an example to support this. Over half correctly stated the role of lone pairs of electrons in deciding bond angles but only a minority gave a suitable example.

Equilibrium

This was tested in the QER question (Q12(a)) and generally it was poorly answered. Marks were lost for a lack of knowledge as well as an inability to express ideas clearly.

Only a small minority of candidates obtained a higher band mark with around half scoring in the lower band. A significant minority did not score any marks. The concept of optimum conditions seemed foreign to most.

To obtain the higher band candidates had to suggest why low temperature and high pressure might be used. For those who obtained the higher band, the main error was not giving a reason why low temperature might not be used or not giving enough detailed information about the reaction.

Candidates scoring in the middle band gave partial answers about the reaction and optimum conditions or just detailed information about the reaction. Many could not apply Le Chatelier's principle and did not refer to equilibrium to explain why the endothermic direction was favoured, giving answers that were too vague.

Candidates scoring in the lower band often gave answers that were very confused. Many stated that the forward reaction was endothermic or that there were more moles in the products. Some even thought that carbon dioxide was the product. The most basic credit was for simply stating the trends from the graphs with no attempt at any reasoning.

Mathematical skills

Q10(c) tested the candidates' abilities to calculate $[H^+]$ from pH and perform an acid-base titration calculation. Most calculated $[H^+]$ correctly but a significant minority used an incorrect expression. Part (ii) was fairly well answered. The main errors were:

- using the volume of acid instead of the titre
- not using the equation to get the 1:2 ratio

In Q11(b)(ii) candidates had to calculate wavelength from ionisation energy. Although many missed the first step (dividing by the Avogadro constant) and failed to convert kJ to J, they only one mark. ECF marks were awarded frequently for the second and third steps. A significant number did not convert m to nm at the end.

In Q12(b)(ii) candidates had to calculate an equilibrium concentration. Over half managed to gain both marks. Some lost marks for rearranging the equilibrium expression incorrectly but a significant number failed to write a sensible K_c expression in part (i).

Many gained at least 2 marks out of 3 for the atom economy calculation in Q12(c)(i). Marks were mainly lost for calculating the mass of the reactants incorrectly or for failing to give the answer to 3 significant figures.

Q12(c)(ii) tested the candidates' ability to change the subject of a formula, to convert from one unit to another and to use stoichiometry. Around one third scored at least 3 marks but a similar number failed to score any marks. The main error was the failure to convert tonnes to grams to calculate the moles of Fe_2O_3 . Many candidates also did not use the given equation so did not multiply by three to get the moles of carbon dioxide. Almost all converted $^\circ\text{C}$ to K and most changed atm to Pa but a minority were unaware that their answer was already in m^3 and so lost a mark for introducing an unnecessary multiplier. Again, some failed to rearrange $pV = nRT$ correctly.

The titration calculation in Q13(e) proved to be very challenging. Part (i) was one of the least well answered parts on the whole paper. A significant number calculated the moles in the sample instead of in the original solution. However, most did not know where to start. Part (ii) was answered better but again many failed to score any marks.

Practical skills

Practical skills were mainly tested in Q9(b)&(c) and Q13. In Q9 candidates needed to know about the observations in the test for halides, the reaction between a halogen and halide and how to use precipitation reactions to distinguish between Mg^{2+} and Ba^{2+} ions.

The vast majority knew the colour of the silver iodide precipitate but most thought that the brown colour in the reaction between bromine and sodium iodide was due to magnesium iodide. Most explained the role of bromine in this reaction in terms of displacement rather than oxidation, which was perfectly acceptable.

The precipitation reactions of Group 2 compounds were only fairly well known with many failing to score a mark. Most of the correct answers involved using the sulfate ion. Another popular choice was silver nitrate – probably because both compounds were iodides – but this did not gain any credit. Some candidates did not realise that they were compounds and tried to distinguish between magnesium and barium by adding them to water.

Q13 was about a double titration. In part (a) candidates had to complete a titration table and calculate the mean volume of both titres. Disappointingly fewer than half scored all 3 marks. The main errors were:

- not giving the titres to two decimal places
- using the first titre in the calculation for the mean titre

Candidates only lost one mark if they made the same type of error twice.

Part (b) saw an array of answers including 'beaker' and 'funnel'. Only about two thirds gave the correct answer of 'pipette'.

Part (c) proved to be the most difficult question on the paper. A few lost the mark for not being specific enough e.g. increasing the amount of solution instead of doubling it. However, the vast majority suggested using a more accurate burette or taking more readings.

Finally, part (d) was well done with over a half giving a correct reason. The difference in the colour changes was the most popular answer but the differences in the closeness of the titres and the fact that the second titre was dependant on the first also proved popular.

CHEMISTRY

GCE

Summer 2024

UNIT 2 – ENERGY, RATE AND CHEMISTRY OF CARBON COMPOUNDS

Overview of the Unit

The paper proved to be accessible for most candidates with high attempt rates for almost all parts. Most candidates had prepared well for the exam although a significant number still lacked some basic recall knowledge. This was evident in Q5, Q7 and Q9(d) which were done particularly poorly.

Many who had a good grasp of basic knowledge lost marks for answers which lacked the required level of detail. This was evident in questions requiring specific definitions (such as Q4(a), Q10(d)(iii) and Q12(a)) and questions involving practical methods (such as Q8, Q10(a) and Q13(b)(ii)).

The organic analysis question (Q11(b)) was not done as well as usual this year as candidates did not link their conclusions about the unknown compound to the relevant information. Further examples of insufficient detail are seen in questions where simple statements and descriptions are given when explanation is required. This was seen in Q4(a), Q10(d)(ii) and Q12(b)(ii).

Comments on individual questions/sections

SECTION A

- Q.1 Just under 60% of candidates correctly answered this question. Including two methyl groups as —CH_3 confused some candidates and the most common error was to give the name of a butane derivative such as 1,1-dimethylbutane.
- Q.2 This question was answered relatively well, with a significant number of candidates gaining at least one of the two marks available. Being a recall question, the errors are mainly explained by a lack of revision. The most common errors included drawing an exothermic reaction profile and incorrect or missing labels.
- Q.3 This question was answered adequately, with many candidates gaining at least one mark. It highlighted the relative lack of understanding of skeletal formula compared to the other formulae used. Errors included giving a shortened structural formula instead of a molecular formula, failing to simplify the molecular formula to give the empirical formula and dividing an odd number of atoms by 2 (when an incorrect molecular formula had been given).

- Q.4 (a) This was one of the worst answered questions, with a little over 25% of candidates answering it correctly. Most candidates had some idea but lacked the necessary precision and clarity of language to gain the mark. The only way to gain this mark was to unambiguously convey the idea that one of the carbon atoms joined by the double bond had two of the same element/group attached to it. Candidates often referred to 'sides' of the double bond which is ambiguous as they could be referring to the top and bottom of the double bond rather than the left and right. A significant number of candidates noted that there was only one chlorine atom, but this was not enough as there are many possible ways to have *E-Z* isomerism in a molecule with only one chlorine.
- (b) This question was answered well, with over 70% of all candidates answering correctly. The most common errors were leaving the double bond in place, failing to draw hydrogen atoms, failing to draw bonds either side of the carbon atoms and drawing an incorrect functional group.
- Q.5 Just under 55% of candidates answered this question correctly. The most common error by far was giving the structure of 1-bromopropane.
- Q.6 Just over 55% of candidates answered this question correctly. The errors in this question were varied due to its unstructured nature, but the most common ones were giving an alcohol with an unbranched chain or giving a tertiary alcohol with an incorrect number of carbons (usually six carbons).
- Q.7 Just under half of candidates answered this question correctly. This is a simple recall question and so the errors made were due to a lack of revision. The full range of common reagents were seen as incorrect guesses.

SECTION B

- Q.8 It was clear that most candidates had very little practical knowledge of measuring enthalpy changes. The mean mark for this question was a disappointing 1.5 out of 6. Despite it being based on a specified practical task, most candidates were unable to give a simple description of the method. Many focused more on the calculation than the detail of the method used to collect results. Those with more hands-on practical experience would have a much better chance of answering well than those with very little.
- Q.9 (a) This question was answered well, with many candidates gaining the 2 marks available, showing a good understanding of the empirical formula calculation.
- (b) Answers here were variable. Some candidates clearly had no idea how to approach it and attempted to reach an answer through seemingly random calculations. Those scoring 1 mark almost always did so by correctly calculating the moles of sodium hydroxide in the solution. Those who were able to use this value to find the moles of acid usually went on to find the relative molecular mass and gain all 3 marks.

- (c) Unfortunately this question was answered very poorly, with a mean mark of 1.4 out of 4. This is likely due to the candidates having to use multiple pieces of information to determine the identity of one of the compounds correctly. The simplest method would be to look at the reaction scheme to determine that D must be a carboxylic acid and use the M_r value of 88 from part (b) to determine that it could only be butanoic acid. From there, candidates could work backwards through the scheme to identify the other compounds. However, many candidates did not use the M_r value and so started with the wrong alkene for A. They were only penalised one mark for this. A significant minority of pupils had no idea what to do for this question and so listed a random selection of chemicals.
- (d) Just under 55% of candidates answered this question correctly. Some clearly had no idea what the correct reagent is but others lost the mark for not including any reference to acidic conditions.
- Q.10 (a) This was one of the worst answered questions, with a mean mark of only 1 out of 4. Most of the marks awarded were for correct calculation of the mass of sodium thiosulfate. Again, the knowledge of one of the simplest methods in chemistry was very poor. Many candidates clearly didn't read the question carefully and described the method for the investigation rather than the preparation of the thiosulfate solution.
- (b) (i) Just over half of candidates answered this question correctly. It was not sufficient to state that the solution becomes cloudy. Credit was awarded for reference to the *precipitate* which causes the cloudiness.
- (ii) This question was answered poorly, with a little under one third of candidates answering it correctly. Common errors included linking the greater surface area of the shallow dish to increased rate of reaction, stating that there is 'more space for particles to react' in the shallow dish and stating that there is no change as none of the factors that affect rate of reaction have changed.
- (c) (i) This question was answered very well, with over three quarters of candidates gaining one or two marks. The most common errors were changing the volume of the hydrochloric acid and increasing the volume of thiosulfate (despite the question stating that it is reduced).
- (ii) This question was answered poorly, with just over 30% of candidates answering correctly. The most common errors were compound units such as $\text{cm}^3 \text{s}^{-1}$, $\text{dm}^3 \text{s}^{-1}$, $\text{mol dm}^{-3} \text{s}^{-1}$ and mol s^{-1} . A small number of candidates changed the power of the seconds unit due to the presence of the factor of 1000, giving units like s^2 and s^{-4} , showing a misunderstanding of the meaning of powers in units.
- (iii) This question was answered very well, with a little under 70% of candidates answering it correctly. Those who did not gain credit attempted to describe the shape of the line but did not convey the idea of proportionality, for example, 'as the volume of thiosulfate increases the rate of reaction increases' was not acceptable.

- (d) (i) This was the best answered question in the paper, with most candidates gaining both marks. Those candidates who did not answer correctly usually misread the equation and multiplied 1000 by 12 instead of dividing.
- (ii) Many candidates obtained at least one mark on this question, with the mark for identifying that the rate doubles every 10°C at the beginning of the experiment. However, few candidates gained the mark for saying that the rate increases by more than double by increasing from 30°C to 40°C. Many did not look at the values at these two temperatures whilst others narrowly missed out by stating that the 'rate does not double at the end'. Another example of lack of the clarity needed for credit at this level.
- (iii) This question was answered relatively poorly, with a mean mark of just under 1 out of 2. The majority narrowly missed out on the second mark by stating that particles moved faster, leading to more successful collisions per second. This answer is acceptable at GCSE, but at AS it is expected that candidates explain this in terms of the number of particles with energy greater than or equal to the activation energy).
- Q.11 (a) This question was answered relatively well, with a mean mark of just below 3 out of 4. Given that two of these marks are for recall of chemical tests first taught at GCSE this is not surprising. It is also not surprising that the most commonly lost marks are for the details taught at AS, i.e. heating the halogenoalkane with aqueous sodium hydroxide and adding nitric acid before adding silver nitrate.
- (b) Given that this style of question has been a part of this paper for many years, it is surprising that the mean mark was only 3.1 out of 8. The main reason why so many marks were lost is because candidates did not link their conclusions to the relevant information. For example, many candidates stated that there were four carbon environments in this compound. However, relatively few explained that the reason they knew there were four carbon environments was because there were four peaks on the ^{13}C NMR spectrum. Another example is candidates stating that the compound has an M_r of 92/94 but not explaining that they found this from the molecular ion peak (also known as $[M^+]$) or the peak with the highest mass.
- Q.12 (a) This question was answered adequately, with a mean mark of just over 1 out of 2. Those candidates who dropped a mark often did so by missing out one of the details, e.g. reference to 'one mole' of a substance or burning 'in excess' oxygen.
- Q.12 (b) (i) I. This question was answered well with over 70% of candidates gaining the mark. Some lost the mark by rounding the final answer to one significant figure.
- (ii) II. This question was answered well, with a mean of just under 2 out of 3 marks. Common errors for this included using an incorrect mass value, calculating the temperature rise incorrectly and failing to divide the energy change by the number of moles.

- (b) (ii) This question was answered poorly, with just over 30% of candidates gaining the mark. Some candidates stated their opinion but failed to explain their reasoning effectively. Some attempted to link the increased time to other unrelated topics, such as rate or equilibrium.
- (c) This question was answered adequately, with a mean mark of just under 2 out of 4 marks. However, many scored all four marks or no marks at all. Candidates who scored well showed clearly how they arrived at their final answer. Those who scored lower marks often had very little working or had seemingly random calculations all over the page.
- Q.13 (a) (i) This question was answered adequately, with a mean mark of just over 1 out of 2. Where candidates gained only one mark, there was no clear pattern in which of the two types of reaction they were able to identify correctly. The most common error was identifying one of the reactions as nucleophilic substitution.
- (ii) This question was answered poorly, with just over 30% of candidates answering correctly. There was no clear theme or pattern to the incorrect answers, with most of them being attempts to answer the question using other topic areas such as equilibrium, energy or bond strength.
- (iii) This question was answered adequately, with a mean mark of just over 2 out of 4 marks. A significant number of candidates knew this mechanism very well, leading to a relatively large number of answers gaining full marks. The mean was brought down by a significant number of candidates with little to no understanding of the mechanism. There remain many candidates who know that these questions involve using arrows, dipoles and lone pairs, but have not learned the specifics of the reaction type and so draw what they consider to be feasible answers but are not correct. Candidates who scored 1 mark on this question usually gained the mark for showing the correct final structure.
- (b) (i) This question was answered poorly, with a mean mark of a little over 1 out of 3 marks. Most candidates were able to calculate the number of moles of ethanoic acid to gain the first mark but very few went further. Those that did know how to do the second step almost always gained all 3 marks.
- (ii) This question was answered relatively poorly, with a mean mark of less than 1 out of 2. Many candidates did not know that cold water must always flow from the bottom of a condenser to the top. Most candidates did not know that the bulb of the thermometer in a distillation must be placed next to the entrance to the condenser. Many drew the thermometer bulb in the reaction mixture, further suggesting a lack of practical experience.

- (iii) This question was very poorly answered, with a mean mark of 0.3 out of 2. Most candidates suggested that the sulfuric acid was acting as a catalyst for this reaction. While this is true a catalyst does not increase the yield of a reversible reaction, but it decreases the time it takes for the reversible reaction to reach dynamic equilibrium. As so many candidates fixated on the effect of the acid on the rate of reaction, they failed to consider its effect on the equilibrium, which would influence the reaction yield.
- (c) This question was answered poorly, with a little over 25% of candidates answering it correctly. It was clear that many had little to no understanding of esterification reactions. Of those who did, a significant number mistakenly drew propan-1-ol as the alcohol and so gave the structure of the incorrect ester.

CHEMISTRY

GCE

Summer 2024

UNIT 3 – PHYSICAL AND INORGANIC CHEMISTRY

Overview of the Unit

The numbers of candidates sitting Unit 3 this year was similar to last year. Almost all candidates attempted all part questions suggesting that the length of the paper was appropriate. Most questions were accessible and discriminated well with the facility factor for almost all lying in the 30-70% range with a very small number of part questions having marks outside this range. All questions with lower facility factors are discussed in the comments section below.

This unit tests a range of knowledge and skills in the areas of physical and inorganic chemistry. Candidates are required to recall, understand and explain many properties, reactions and observations in inorganic chemistry. The physical chemistry work often requires more mathematical answers and this unit contains much of the mathematical content from the A2 course. The work requiring descriptions, explanations or calculations in familiar contexts was generally good but where these required application in less familiar contexts the standard of responses was much lower.

The unit requires candidates to recall and apply knowledge and skills, to analyse evidence and come to judgements. Most candidates were able to recall and apply basic concepts and observations across a range of topics, with many also able to use the more complex concepts.

There was no significant difference between the performance of candidates on English and Welsh-medium papers.

Comments on individual questions/sections

SECTION A

Questions in Section A are generally short and focus on AO1 and AO2 skills. Most candidates could answer questions requiring recall but those that needed application of knowledge or skills to unfamiliar contexts were less successfully answered.

- Q.1 (a) Only one in three candidates gained this mark with most not showing the ions in the gaseous state.
- Q.3 Few candidates gained both marks in this question with the most common answer being 12.4. Many failed to realise that each calcium hydroxide releases two hydroxide ions. Some candidates tried to calculate pH without using K_w and gained no marks.
- Q.4 Many answers referred to the hydrogen fuel cell only producing water or not producing carbon dioxide. This repeats the information in the question and does not gain credit as the question emphasises that it needs one *other* advantage.

- Q.5 Many candidates identified the importance of the inert pair effect although not all could describe the pattern in oxidation state stability arising from it. It was disappointing to see many answers suggesting a +2 oxidation state showing that these candidates were not able to apply what they had learned about Group 4 elements to this Group 5 element and simply repeated the oxidation state they had seen for lead.

SECTION B

- Q.6 Most candidates were able to gain marks for the factual content in parts (a) and (c) however part (b) was more challenging. Many did not appreciate the difference between the terms structure, bonding, properties and uses. It was common to see properties and uses included in part (b)(ii) even though they are not needed. It was also common to see discussion of bonding in the differences in structure answer and vice versa. Candidates need to remember that any question asking for differences needs reference to both species to ensure that differences are made clear – stating that graphite has delocalised electrons as a difference is not sufficient unless there is a reference to the lack of these in boron nitride.
- Q.7 Parts (a), (b), (c) and (e) were generally well answered but part (d) had one of the lowest facility factors on the paper where only one in twenty gained the mark. The majority did not make the link between this question and the rate equation they gave in part (c) and could not suggest reactants. Others gave the reactants but could not write products that gave a balanced equation. It was common to see equations that did not attempt to balance charges.
- Q.8 Most parts of this question were well answered with facility factors over 50%. Some errors were frequently seen in parts (b), (c)(ii) and (d)(ii).

In part (b) many candidates thought that the colour observed was linked to the frequencies with the highest absorbance rather than the frequencies with the lowest absorbance.

In part (c) most candidates could extract the half-equation for oxidation of iodide ions but many found the equation for reduction of VO_2^+ more challenging. It was common to see equations that were not balanced in terms of charge.

In part (d)(ii) it was disappointing to see answers that included the value $-187 \text{ J K}^{-1} \text{ mol}^{-1}$ in the calculation. This is clearly marked as an entropy change in the equation and candidates should know that this cannot be used to calculate an enthalpy change of formation.

- Q.9 Part (a) was answered well but much of part (b) challenged candidates. Part (b)(i) had a low facility factor and a wide range of incorrect answers. The equation in (b)(i) often had a compound of silver and copper as a product. Even candidates that gave the correct reactants and products often did not attempt to balance the equation. The discussion of the standard electrode potential in part (b)(i)II was poor. Many couldn't relate the direction of the reaction to the value of the standard electrode potential.

In part (b)(ii) most candidates gained at least one mark for the calculation of the electrode potential. The explanation of the pattern of EMF values at different concentrations was poor in many cases. Few candidates could fully explain the impact of changing concentration using Le Chatelier's principle.

Q.10 Parts (a) and (b) are focused on water extracted from Afon Goch. Many candidates were able to gain marks for most practical methods and calculations. Parts (b)(ii) and (b)(iv) were the most challenging for candidates.

Part (b)(ii) requires two reasons for using excess sodium hydroxide but many candidates gave just one reason, often adding an observation or an equation. More than one mark could not be credited without a second reason.

Part (b)(iv) requires candidates to identify whether the solutions are the same or different. To do this the candidates must consider the percentage difference and the percentage error. It was not uncommon to see candidates discussing one only of the two and concluding that the solutions were the same. By comparing the percentage error and the percentage difference we can see that the difference is larger than the error and so the solutions must have different concentrations.

Part (c) includes the QER question for the paper. Few candidates gained all 6 marks but most gained some marks. The question is structured with three bullet points and unfortunately it was common to see answers that addressed one or two of these only. Some candidates gave vague answers, especially to the second bullet point, and did not fully explain the entropy change and how this leads to a negative Gibbs free energy. It was common to see answers to the third bullet point that simply stated that a negative Gibbs free energy change meant that the reaction was feasible rather than linking this to the position of equilibrium and hence K_c .

CHEMISTRY

GCE

Summer 2024

UNIT 4 – ORGANIC CHEMISTRY AND ANALYSIS

Overview of the Unit

This Unit 4 paper allowed all candidates the opportunity to show what they had learnt over two years of studying organic chemistry. The mean mark for the paper was almost exactly half marks and there was a good range and distribution of marks. Several questions challenged the more able candidates which helped discriminate at the top end. For example, Q10(a) (QER question), several calculations and Q11(c) on plane-polarised light rotation were areas of the paper where only the most able performed well.

Most candidates attempted every question, to varying degrees of depth and understanding, showing a good degree of knowledge of the specification. They had clearly used previous papers in their preparation and many were able to recall numerous reagents, reaction types and mechanisms throughout the paper.

Comments on individual questions/sections

SECTION A

Although most candidates were able to draw out the ester structure in Q1 a lot of them did not get the mark because they forgot to balance the equation by adding HCl as the second product. Q2 was well answered, but several incorrectly referred to the light which is not absorbed in part (b).

Q3 on infrared spectra was understood and answered well. However, only one in five could draw the triphenyl radical in Q4. Most confused a phenyl group with phenol.

Q5 also saw some excellent answers with many candidates labelling equivalent carbon environments on the structure to ensure clarity in their explanation.

The mean mark for this section was 6 out of 10.

SECTION B

Q7 Most candidates scored quite well on this question but several parts were poorly answered. Only a minority recognised that a nitro group is reduced to form an amine group. Only one in four could recall nitrous acid as the reagent used to turn an amine into an alcohol. A similar number gave the correct structure for the compound coupled with the given amine to form methyl orange.

However, candidates could generally recall oxidation and electrophilic addition from their year 12 work. In addition, they many successfully applied their knowledge of organic reactions to larger and unfamiliar structures such as those in part (d).

Q8 Much of part (a) was well answered by most, but the first and last parts were poorly done. Barely any candidates recognised sodium hydroxide acting as a base in part (i). Whilst this is quite understandable it was surprising that only one in three correctly answered part (iii)III. Many suggested an 'average melting temperature' rather than recognising a mixture of compounds as an impure sample, therefore having a lower melting temperature than both pure substances.

Part (b) was answered well by most, and practical aspects such as the use of a separating funnel and the iodoform test produced a lot of good responses. The ^1H NMR question was also well done, but the later question on ^{13}C NMR showed a number of misconceptions and confusion with ^1H NMR. Part (iv)I was reasonably well done with most candidates gaining the first mark for recognising the presence of hydrogen bonding in alcohols. Only a small number linked this to needing more energy to separate the molecules.

Q9 This question was well answered by most but two parts in particular proved challenging. Three out of four candidates balanced the equation correctly in (a)(i) and most who read (a)(ii) carefully gained the mark by referring to the high cost of the catalyst or maintaining high pressure. Part (a)(iii) however was a good discriminator with the full range of marks awarded. Part (b)i was very well answered with most getting the correct answer of 45 cm^3 . However, very few scored more than one mark out of three for the calculation in (b)(ii). It was rare for anything other than the first marking point to be credited.

Part (c) was a difficult equation to balance and one slip in a formula resulted in both marks being lost. A good number gave all the correct formulae but only very few gained both marks. Part (d) was a different type of mole calculation with key information presented in graphical form. Most extracted the information correctly but few showed an understanding of the link between this and the equation given in the question.

Most candidates gained the mark in part (e). Many gave 4-ethylbenzene rather than ethylbenzene but this was accepted.

Q10 Part (a) was the QER question and was, as ever, an effective discriminator with a good range of marks awarded. Top band answers utilised all the data provided to identify the unknown structure, with middle and lower band answers using varying amounts of the information to propose structures containing some of the features present in the correct one.

It was more common for the second mark to be awarded than the first in part (b)(i) as most did not realise that 1 mol of sucrose reacts with 8 mol of anhydride. Part (b)(ii) gave most candidates 1 mark but no credit was awarded for reference to risks associated with ultrasonic irradiation. Part (c) was well answered.

Q11 Part (a)(i) was not well answered with many students incorrectly giving the formula of ammonia as NH_2 . As is standard, no balancing mark was possible unless the correct formula was given.

Part (a)(iv)I was well answered by those who realised that the main advantages revolved around the process being just one step rather than two and/or that ammonia was not produced. Unfortunately, many candidates lost the mark in part II because they did not read the question carefully. They understood that this reaction gives effervescence as nitrogen gas is released but the question asks for the observation which shows that the reaction is *complete*, i.e. that there is no further effervescence.

Whilst parts (b)(i)&(ii) were well answered, too many candidates lost at least one mark on the chromatogram question by reading the scale incorrectly and/or not noticing that the start line is at 1 cm rather than 0 cm.

Part (c) was another unfamiliar question requiring the application of simple knowledge in a graphical question. Most candidates either understood the idea or they did not and subsequently scored 0 or 3 marks. Some gained a mark for adding scales to the graph but could go no further.

CHEMISTRY

GCE

Summer 2024

UNIT 5 – EXPERIMENTAL TASK

Overview of the Unit

The Experimental Task allowed candidates to demonstrate skills and apply knowledge in thermochemistry and inorganic analysis. They collected quantitative and qualitative results to be processed and interpreted in the analysis section.

Most candidates scored marks in the range of 20-28 out of 30. All could access all parts of the task.

Comments on individual questions/sections

Results

Most recorded their results for the thermometric titration in appropriate well-organised tables. Marks were occasionally lost for missing units or lack of precision in recording volumes or temperatures. Some did not follow the instructions given in bold print.

The practical worked well giving the expected results in almost all cases. It was obvious that some candidates misread the instructions as their results did not follow the expected pattern. These lost one or two marks in the Results section but they were not penalised further in the Analysis section.

The qualitative tests were carried out correctly by almost all but some clearly mixed up their solutions, which led to them recording precipitates in the wrong boxes. Again, errors here were not penalised for a second time in the Analysis section.

Analysis

- (i) & (ii) The graphs were constructed well by most but the following errors were commonly seen
- labelling the y-axis as *temperature* rather than *temperature increase*
 - using an inappropriate scale which resulted in the lines intersecting above the grid itself
 - not following the instructions to draw a straight line through the first two points and a straight line of best fit through the last three points
- (iii) & (iv) Although the concentration of the acid was correctly calculated by most, many candidates dropped marks carelessly in calculating the enthalpy change of neutralisation. The following errors were commonly seen
- incorrect reading of the temperature increase at the point of intersection
 - adding 273 to the temperature increase
 - incorrect number of moles used
 - incorrect total volume of solution used
 - not adding a negative sign to the final enthalpy change value

- (v) Nearly all candidates identified the metal ions present in the unknown solutions. However, many struggled to give clear reasoning. It was common to see the observations repeated rather than explanation in terms of the solubility of the relevant chlorides and sulfates.
- (vi) Few managed to identify sodium hydroxide as the solution that would have the largest enthalpy change of neutralisation. Fewer still linked their choice to the solubility of the sulfates.

CHEMISTRY

GCE

Summer 2024

UNIT 5 – PRACTICAL METHODS AND ANALYSIS TASK

Overview of the Unit

Following a change to the specification, candidates were given a list of the main themes or topics for assessment in this paper and the Experimental Task. As expected, that proved to be helpful for candidates on this paper in particular. The mean mark was 16 out of 30.

The paper was successful in that it differentiated well. Some marks were accessible to almost all candidates whilst others were gained only by the most able. This led to a good distribution of marks with the most able candidates getting close to full marks.

Good attempts were made at the calculation questions. Most candidates set out their answers sufficiently clearly for credit to be given for correct steps in the method even when the final answer was incorrect.

There was no indication that candidates had a problem with the length of the paper. When questions were not attempted it was usually due to a lack of knowledge and understanding rather than a shortage of time.

Comments on individual questions/sections

Q.1 Most candidates gained at least 2 of the 5 marks for this question. They were able to label the positive electrode on the electrochemical cell and describe how to make a salt bridge. Any suitable salts were accepted but no credit was awarded for a salt of $\text{Fe}^{2+} / \text{Fe}^{3+} / \text{Cu}^{2+}$.

The equation for the overall reaction and the observations at both electrodes proved to be more challenging. Although the question stated that the Fe/Fe^{2+} half-cell has a more negative electrode potential than that of the Cu/Cu^{2+} half-cell, the question did not give the two half-equations and thus a variety of incorrect answers were seen. Observations had to refer to the colour *change* in the half-cell, a decrease or increase in the mass/size of the electrode or a deposit of copper on the copper electrode. Common incorrect observations included:

- oxidation/reduction occurs
- fizzing
- solution goes from *colourless* to green
- *rusting* on the electrode as copper is formed

- Q.2 (a) A similar question has been asked in a previous year so the vast majority of candidates gave an acceptable answer here.
- (b) Fewer candidates could explain why the addition of boiling water to the conical flask does not affect the titration results. Common answers not gaining credit included:
- adding water does not change the concentration
 - it's not a thermometric titration
 - water has a pH of 7
- (c) This required some thought about exactly what is happening. Many incorrectly gave purple or colorless.
- (d) Nearly all candidates completed the table of titre volumes correctly, although a few lost a mark for not recording all values to 2 decimal places. Pleasingly, the majority went on to identify concordant volumes and calculate the mean titre as 27.15 cm³.
- (e) Well answered, with the majority of candidates able to complete and balance the redox equation.
- (f) Although there was no scaffolding for this volumetric calculation, a number of candidates scored 2 out of the 4 marks for correctly calculating the number of moles of MnO₄⁻(aq) used in the titration and for using the 3:5 ratio in the equation to find the number of moles of FeC₂O₄·xH₂O in 25.0 cm³ of solution. Only a small minority of candidates calculated the value of *x* as 2. One of the most common errors was not scaling up from 25 cm³ to 500 cm³ (giving a huge *M_r* and value of *x* as 192!)
- Q.3 (a) This question clearly differentiated between those that had revised the organic functional group tests and those that had not. It was surprising to see that a number of candidates were unable to score any marks for this question.
- Some excellent answers were seen with clear reasoning linking the observations given in the table to the organic structures drawn. Many candidates were able to describe why compound **A** contained a carbonyl group but not an aldehyde and why it contained an aromatic amine due to the formation of the red azo dye in Test 5. Some also correctly identified compound **C** as containing an amide group due to the formation of ammonia gas on hydrolysis with NaOH(aq) and concluded that the other group had to be a methyl side chain, given that the molecular formula was C₈H₉NO. Some candidates correctly identified compound **A** as containing a ketone group and compound **B** as containing an aldehyde group but drew the structures incorrectly with, for example, the carbonyl =O attached directly to the aromatic ring or the amine group having three hydrogen atoms.
- (b) This question required candidates to draw the structures of the azo compound formed in Test 5 and the organic product formed on alkaline hydrolysis of the amide group on compound **C**. Only a very small minority of candidates gained both marks.

- (c) In part (i) of this question, candidates were told to use the ideal gas equation to calculate the number of moles of gas formed. Common errors seen included:
- failing to rearrange the equation correctly
 - not converting 1 atm to $1.01 \times 10^5 \text{ Nm}^{-2}$
 - not converting temperature in $^{\circ}\text{C}$ to K
 - not converting the volume of gas from cm^3 to m^3

Finally, in part (ii), a straightforward calculation of the concentration of compound **B** in g dm^{-3} . The stem of the question states that the mole ratio of compound **B** to the gas formed is 1:1 and that M_r for compound **B** is 135.09. However, all too often, candidates calculated the concentration in mol dm^{-3} rather than g dm^{-3} . Another common error was to use the volume of the gas and not the volume of the solution in the calculation.

Supporting you

Useful contacts and links

Our friendly subject team is on hand to support you between 8.30am and 5.00pm, Monday to Friday.

Tel: 029 2240 4252

Email: science@wjec.co.uk

Qualification webpage: [AS/A Level Chemistry \(wjec.co.uk\)](http://www.wjec.co.uk)

See other useful contacts here: [Useful Contacts | WJEC](#)

CPD Training / Professional Learning

Access our popular, free online CPD/PL courses to receive exam feedback and put questions to our subject team, and attend one of our face-to-face events, focused on enhancing teaching and learning, providing practical classroom ideas and developing understanding of marking and assessment.

Please find details for all our courses here: <https://www.wjec.co.uk/home/professional-learning/>

WJEC Qualifications

As Wales' largest awarding body, WJEC supports its education community by providing trusted bilingual qualifications, specialist support, and reliable assessment to schools and colleges across the country. This allows our learners to reach their full potential.

With more than 70 years' experience, we are also amongst the leading providers in both England and Northern Ireland.



WJEC
245 Western Avenue
Cardiff CF5 2YX
Tel No 029 2026 5000
Fax 029 2057 5994
E-mail: exams@wjec.co.uk
website: www.wjec.co.uk