Examiners' Report
Principal Examiner Feedback

Summer 2025

Pearson Edexcel International GCSE in Chemistry (4WCH2) Unit 1CR

Summer 2025
Publications Code 4WCH2_1CR_2506_ER

Grade Boundaries

What is a grade boundary?

A grade boundary is where we set the level of achievement required to obtain a certain grade for the externally assessed unit. We set grade boundaries for each grade, at Distinction, Merit and Pass.

Setting grade boundaries

When we set grade boundaries, we look at the performance of every learner who took the external assessment. When we can see the full picture of performance, our experts are then able to decide where best to place the grade boundaries – this means that they decide what the lowest possible mark is for a particular grade.

When our experts set the grade boundaries, they make sure that learners receive grades which reflect their ability. Awarding grade boundaries is conducted to ensure learners achieve the grade they deserve to achieve, irrespective of variation in the external assessment.

Variations in external assessments

Each external assessment we set asks different questions and may assess different parts of the unit content outlined in the specification. It would be unfair to learners if we set the same grade boundaries for each assessment, because then it would not take accessibility into account.

Grade boundaries for this, and all other papers, are on the website via this link

Introduction

This is the first examination series for IGCSE Chemistry modular paper 2 (4WCH2/1CR).

The content examined is the same as for the IGCSE Chemistry linear 4CH1 papers, but the total number of marks is 90. This question paper followed a broadly similar format to 4CH1, with ten questions and 44 test items in total. There was a mix of different types of question which included: several multiple-choice or multiple response questions; single mark questions mainly testing recall or application of knowledge; completion of diagrams or graphs to a high degree of accuracy and precision; a variety of routine and non-routine calculations; 2 or 3 mark questions requiring description or explanation of a chemical idea, process or practical procedure; and extended response questions of 4, 5 or 6 marks, which provided candidates with the opportunity to interpret and communicate their understanding of a given context.

The following topics were covered:

- Question 1: catalysis; the effect of a catalyst on the rate of a reaction; identifying the most effective catalyst; sketch a curve to show change in rate of reaction when a catalyst is removed (7b)
- Question 2: charges of ions; calculation of amount of substance and gas volume (5f, 1e)
- Question 3: identification of metal ion from a flame test colour; describing the test for a carbonate ion / carbon dioxide gas; constructing the formula of a compound from chemical test results (6h, 5f)
- Question 4: giant covalent and simple molecular structures; similarities and differences in physical properties of covalent substances (e.g. electrical conductivity) (5g)
- Question 5: determination of formulae of lead oxides by reduction; practical details of an investigation; word equation for a reaction; constructing a linear graph and finding the gradient; determining empirical formula (1e)
- Question 6: addition polymers; drawing a dot-and-cross diagram of a monomer and a repeat unit of its polymer; calculation of number of repeat units and carbon atoms; understanding problems in using polymers (8h, 5g, 1e)
- Question 7: electrolysis; malleability of metals; formation of ions by electron loss and gain; comparison of giant metallic and giant ionic structures to explain a difference in melting points (5i, 5h, 5f)
- Question 8: chemical test for chlorine; reversible reaction involving chlorine; chemical equation for a reversible reaction; changes and observations for the reverse reaction; effect of temperature upon rate of reaction; amount of substance and percentage yield calculation (6h, 1e, 7c, 7b)
- Question 9: halogens; physical properties of halogens; reacting masses calculation; halogen-halide displacement reactions (6f, 1e)

- Question 10: alcohols, carboxylic acids and esters; action of acidified potassium dichromate (VI) on ethanol and on ethanoic acid; safety in the preparation of ester practical; properties of an ester; naming an ester; drawing the displayed formula of a polyester; calculation of amount of substance, stochiometric ratios and reacting masses (8e, 8f, 8g, 1e)

Areas where candidates performed well were:

- recalling the characteristics of catalysts and identifying the most effective – Q1
- performing routine calculations – Q2 and Q8
- recalling tests and results for gases and ions – Q3 and Q8
- knowing that delocalised electrons can carry an electrical charge for some covalent substances – Q4
- plotting and analysing graphs – Q5
- identifying addition polymerisation and being able to draw a repeat unit for a common polymer – Q6
- using a diagram to explain why a metal is soft – Q7
- understanding how ions are formed – Q7
- being able to suggest how to reverse a given reaction and some of the observations that might be made – Q8
- explaining the effect of temperature on the rate of reaction – Q8 • deducing order of reactivity from results – Q9
- drawing displayed formulae for organic molecules – Q6 and Q10

Areas where candidates did **not** perform as well were:

- being able to sketch a graph to fully show the effect of removing a catalyst from a reaction – Q1
- having a complete knowledge of charges of common ions – Q2 and Q3
- knowing and recognising the main four types of structure – Q4 and Q7
- comparing two structures and the difference in a physical property (e.g. electrical conductivity, melting point) – Q4 and Q7
- knowing or understanding steps in the determination of the formula of a metal oxide – Q5
- drawing appropriate best fit lines for plotted data – Q5
- fully completing dot-and-cross diagrams – Q6
- applying stochiometric ratios in calculations – Q6, Q9 and Q10
- extended line of reasoning in explanations – Q4, Q6 and Q7
- when and how to apply electrolysis – Q7
- correct and accurate use of chemical terminology – Q7
- practical observations and safety in organic chemistry – Q10

Individual Questions

Question 1

This question was about catalysts and the effect on rate of reaction.

Q1(a)

The majority of candidates were able to suggest an appropriate word or way to end each of the three sentences.

Q1(b)

Almost all of candidates identified catalyst Q as giving the fastest reaction.

Q1(c)

A significant number of candidates were able to sketch a curve that was lower than the original but finished at the same level. Generally, when candidates only scored 1 mark, this was for realising that the rate of reaction would be slower without the catalyst and so that the initial gradient of the curve would be less steep.

Question 2

This question was about ionic charges and the calculation of the volume of hydrogen gas produced.

Q2(a)

A significant number of candidates were able to correctly link at least two of the named ions to the correct charge. In general, it was the charge of the sulfate ion that was best known, and the charge of the zinc ion was more likely to be incorrect. Candidates that could not recall the charges may have tried to deduce the ions from the equation for the reaction.

Q2(b)

It was rare for a candidate not to score any marks on this question, and the majority of responses showed that the volume of hydrogen gas produced was 6000 cm^3.

Question 3

This question was about the identification of an unknown ionic compound from the positive results of two chemical tests.

Q3(a)

Most candidates were able to identify that the lithium ion produced a red flame colour in a flame test.

Q3(b)

The majority of candidates were able to describe the test and result for carbon dioxide and thereby confirm the presence of carbonate ions. Many candidates scored at least two marks, with the main reason for not achieving full marks often being not identifying that the gas was carbon dioxide.

Q3(c)

This question was intended for the very best candidates, and the number of correct responses was consistent with this. A range of skills were required. Candidates needed to identify the metal ion from the result in the flow chart, recall the charges of the ions and construct the correct formula. The carbonate formula was often correctly written and it was the metal ion which was incorrect, with the formula for calcium carbonate being commonly observed.

Question 4

This question was about graphite and C_{60} fullerene.

Q4(a)

Candidates did not perform as well as would have been expected on this question, which was to name the types of structure presented. Both the name of the type of carbon and a diagram of the structure was supplied, which gave candidates different ways to approach this question. However, candidates scoring both marks, or even 1 mark, were in the minority. In some cases, terminology for the names was only partially given or was poorly expressed e.g. “giant lattice”, “giant structure”. It was common to find that instead of offering names, candidates would try to describe the number of bonds or the shape in some way (e.g. layers, spherical, bee-hive, etc) and some drew geometric shapes or organic molecules for their answer. Occasionally, the structure names were mixed up, or giant metallic and/or giant ionic would be suggested. This would appear to be an area for candidates to be better prepared.

Q4(b)

Again, candidates did not perform as well as might have been expected on this question, and only a minority of candidates were able to give a valid response. Although a large number of candidates had just previously given good description of the shape of C_{60} in Q4(a), this was not further used in answer to this question. The most common answer was “weak intermolecular forces” to explain the use of C_{60} as a lubricant. Whilst this gained the mark, it did not show a full appreciation of the diagram supplied. It was rare to see a response that suggested that the C_{60} molecule could roll or move as a result of its shape.

(b) Graphite and C_{60} fullerene can be used as lubricants.

In graphite, the layers move over each other easily.

Suggest why C_{60} fullerene molecules move over each other easily.

(1)

Due to its spherical shape

Suggest why C_{60} fullerene molecules move over each other easily.

(1)

~~The shape causes~~ The shape is a ~~cir~~ ball thus causing decreases friction

Suggest why C_{60} fullerene molecules move over each other easily.

(1)

C_{60} fullerene molecules move over each other due to its weak intermolecular force of attraction

Principal Examiner comment:

A selection of responses which each score 1 mark.

Q4(c)

This question discriminated well between the best candidates and the rest of the cohort. Only the best candidates were able to give an answer that scored 2 or more marks. In general, most candidates were aware that "delocalised electrons" were the reason for electrical conductivity in graphite. However, it was not well known that C_{60} fullerene molecules also had delocalised electrons, and many concluded that a lack of this was the reason that C_{60} had poor electrical conductivity. Consequently, a more critical comparison of the two structures was not given to explain the difference in conductivity.

(c) Graphite conducts electricity better than C_{60} fullerene.

Explain this difference.

(3)

Graphite: giant covalent structure
covalent bonding
delocalised electrons are free to move
C_{60}: simple covalent structure
covalent bonding
electrons are not free to move

Principal Examiner comment:

This response scores 1 mark. It was common to see the recognition of delocalised electrons in graphite but not for C_{60} fullerene.

(c) Graphite conducts electricity better than C_{60} fullerene.

Explain this difference.

(3)

graphite has delocalised electrons that move freely throughout the structure

Principal Examiner comment:

This response scores 2 marks. In addition to identification of delocalised electrons, the candidate has indicated that these can travel throughout the structure for graphite.

(c) Graphite conducts electricity better than C_{60} fullerene.

Explain this difference.

(3)

Graphite has a sea of delocalized electrons that can move freely and conduct electricity.

C60 fullerene does have free electrons; however, the electrons can not move from one C60 fullerene ball to the next.

Principal Examiner comment:

This response scores 2 marks. The response is too ambiguous for 3 marks, but the candidate does infer that electrons are delocalised or can move in both structures, but that electron movement is restricted to a C_{60} molecule.

Q4 would suggest that the structure and properties of C_{60} fullerene is not an area well known by candidates. Centres are advised to focus more closely upon this part of the IGCSE Chemistry specification.

Question 5

This question was about a practical to determine the formulae of different lead oxides by reduction and plot data to create a linear graph for the comparison of results.

Q5(a)(i) and **(ii)**

Collectively, the two parts of this question were intended to discriminate between candidates on their knowledge of this practical. It also required some clear expression of how to complete or use measurements from the investigation.

For part (i), candidates were generally able to provide reasonable responses indicating that the difference between the mass of the tube and its contents before and after heating would give the mass of oxygen. Better responses tended to provide an expression showing the subtraction of the mass of the tube with lead from the mass of the tube with lead oxide. Candidates that failed to score did so for various reasons. Some did not consider the context and instead came up with methods of collecting oxygen gas. In some responses, it was unclear what object of mass was being referred to and sometimes there was no reference to “mass” at all, rendering a statement meaningless.

For part (ii), most candidates were either unfamiliar with how to carry out this particular type of investigation or were unable to express themselves with sufficient clarity.

Candidates that were able to gain credit on this part tended to score the second marking point, which was to achieve a “constant mass”.
Candidates were less likely to offer that the tube and its contents should be reheated and reweighed until this point was reached.

(ii) Describe what the scientist should do next to check that the reaction is complete.

(2)

heat again

make sure the mass of tube doesn't change

Principal Examiner comment:
This response scores 1 mark. The candidate indicates that they are looking for no change in mass after heating but would need to make clear how they would know this and give a statement that re-weighing of the tube would be needed.

(ii) Describe what the scientist should do next to check that the reaction is complete.

(2)

Keep heating the contents of the tube & reweigh until constant mass.

Principal Examiner comment:
This response scores 2 marks. The response is sufficiently clear that the tube and contents are to be re-heated and re-weighed until the mass remains constant.

Q5(a) would suggest that the practical details for the determination of the formula of a metal oxide by reduction are not well known by candidates. Centres are advised to focus more closely upon this part of the IGCSE Chemistry specification.

Q5(a)(iii)
This question met with a varied response by candidates. It was intended to test basic understanding and use of a word equation, although this also required a good appreciation of the context as the secondary product was not stated. Consequently, many candidates did omit water from their equations, either implying that oxygen just disappeared or proposing a different product to lead, such as lead hydroxide. Some did not read the question carefully or chose to overlook that a word equation was required, and provided the chemical equation
$PbO + H_2 \rightarrow Pb + H_2O$

Candidates must be clear about the different types of equation that are used to represent reactions and not to simply assume a chemical equation is the default when an "equation" is asked for.

Q5(b)

Whilst many candidates were able to determine the gradient of the linear graph for PbO, many were not. Common errors were to misread the graph, leave the answer as an unresolved fraction, or divide a change in mass of lead (x axis) by a change in mass of oxygen (y axis).

Q5(c)(i), (ii) and **(iii)**

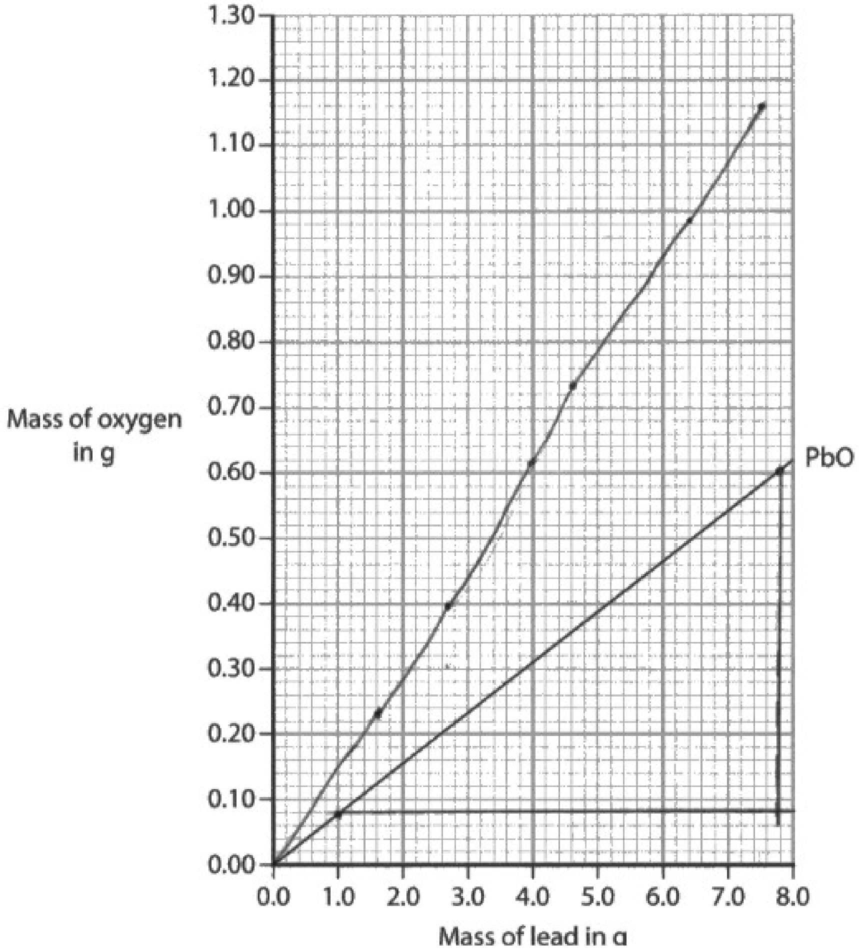
For the unknown compound T, most candidates were able to accurately plot the data on the grid with no or minimal error. Occasionally, candidates would draw extremely large points which were unacceptable as this made the accuracy difficult to ascertain.

The high level of accuracy shown with plotting was not always continued with the line of best fit. Although the data (and the existing graph) suggested a straight line, a worrying number of candidates clearly did not use a ruler. Candidates that did, typically did well as there were no obvious anomalies in the data to worry about.

The deduction of the empirical formula for compound T required candidates to make use of the graphs but was an atypical approach. Some candidates resorted to determining a stoichiometric ratio for lead and oxygen to arrive at the formula. This was credited but was more work than was required. More efficient candidates observed that for any given mass of lead, the mass of oxygen was always double for compound T compared to PbO. Occasionally, the gradient of the graph for compound T was determined and compared with the answer for (b).

(b) The experiment in part (a) is repeated using different masses of PbO.

The graph shows the masses of lead and oxygen found in these experiments.



Principal Examiner comment:

This response scored 1 mark for part (i) but 0 marks for part (ii), as the best fit line is clearly not straight.

Question 6

This question was about addition polymerisation, completing a dot-and-cross diagram for an organic molecule, drawing the displayed formula of a repeat unit of poly(chloroethene) and problems with the use of inert polymers.

Q6(a)

Most candidates were able to identify the type of polymerisation. Common incorrect answers included “condensation” and “synthetic”, whilst other candidates misinterpreted the question and offered compound names or formulae.

Q6(b)

Most candidates scored at least one mark for their dot-and-cross diagram of chloroethene, but only the best candidates were able to correctly complete the diagram. The majority of these responses showed that the carbon-carbon overlap was completed with four electrons, but that the chlorine atom was not fully completed.

Q6(c)

Many candidates were able to draw the displayed formula for one repeat unit of poly(chloroethene) correctly. Common errors tended to be to omit the extension bonds from the carbon atoms, show a double bond in the diagram or forget the Cl atom.

Q6(d)

Although this calculation involved fairly basic processing, candidates found the final step of this non-routine problem challenging. Careful understanding of what was being asked by the question was needed and discriminated the best candidates from the rest of the cohort. Most candidates were able to calculate the number of repeat units within the poly(chloroethene) chain, but relatively few realised that as there were two carbon atoms per repeat unit, the final answer should be doubled.

Q6(e)

Most candidates were able to score at least one mark on this question, but many were unable to expand fully. A number of candidates simply stated what inert meant rather than explore what the issue may be arising from this. Other candidates tried to discuss methods of disposal (e.g. burning, need for landfill sites) which missed the point of the question. Better candidates were able to link the inert behaviour with the difficulty in breaking down poly(chloroethene). Only the best candidates were able to build upon this specifically using the context.

(e) Poly(chloroethene) is suitable for making underground water pipes because it is inert.

Explain a problem caused by poly(chloroethene) being inert.

(2)

Poly (chloroethene) is not biodegradable as it is inert therefore it Stays in the enviroment for thousand of years and harms the enviroment and wild life as they may eat it.

(Total for Question 6 = 9 marks)

Principal Examiner comment:

This response scores 2 marks. The response links that poly(chloroethene) being inert makes it non-biodegradable. Although aspects of the rest of the answer could do with clarification, the expansion correctly implies that the material will remain in the environment for a long time, rather than how it should be disposed of.

Question 7

This question was about sodium and sodium oxide, metallic and ionic bonding, and the effect of the difference in bond strength upon melting point.

Q7(a)

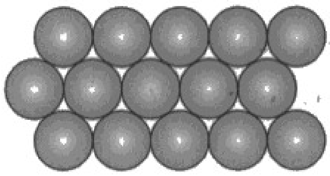
This question was weakly answered in general. A number of candidates discussed removing or losing oxygen without providing any detail of how to do this, whilst others described electron transfer. Candidates seemed unclear about an appropriate technique to extract a reactive metal from its compound. It was not uncommon for combustion or reaction with oxygen to be proposed. Many candidates suggested a displacement reaction with carbon or hydrogen (possibly taking the idea from Q5) but had not appreciated that sodium would be too reactive to extract in this way. A compensatory mark was given to candidates which did suggest the use of potassium. However, the expected process of electrolysis was observed more frequently than this. Candidates that did suggest electrolysis often omitted to indicate that it should be melted. Even suggestions of heating or dissolving, which would not have been quite sufficient to score the first marking point, were rare to observe.

Q7(a) would suggest that knowledge of the use of electrolysis to extract reactive metals from their molten compounds is not well known by candidates. Centres are advised to focus more closely upon this part of the IGCSE Chemistry specification.

Q7(b)

A range of responses were observed from candidates to this question. The diagram provided a useful stimulus for answers, although identification of the regularity of arrangement into layers or rows was not always stated. Many candidates were able to indicate that atoms or ions could slide over each other, revealing good preparation to answer this question. Occasionally, there were errors such as reference to electrons, negative ions or suggestion of molecules, which could be indicated by the use of “intermolecular forces” in the answer. Incorrect identification of the type of particle would discredit a candidate’s entire response and centres are advised to coach candidates carefully in their choice of terminology.

(b) The diagram shows the arrangement of particles in a pure metal.



Explain why pure metals are soft.

(2)

pure metals have gaps in between delocalised electron and negitive ions, which makes them malleable and can be shape into anything. another reason the structure might be in layers. pure metal atoms can slide over each other.

Pure metal has weak intermolecular forces between atom and less energy is required because they are single substance not compound. require less energy to break the bond

Principal Examiner comment:

This response scores 0 marks. The candidate identifies layers and atoms at points, but also refers to delocalised electrons, negative ions uses the term intermolecular forces which infers molecules. The candidate offering more than one explanation also makes the response uncreditworthy.

Q7(c)

Candidates generally identified that electrons transferred from sodium to oxygen. Answers often went into good detail about the electronic configurations and ions that formed. Many candidates were able to articulate the numbers of atoms and electrons involved clearly enough to secure both marks.

Q7(d)

Relatively few candidates were able to give a good explanation for the difference in melting point between sodium and sodium oxide. Many students missed out on standalone marks such as the identification of the type of structure – it was more common for this to be omitted or misidentified for sodium than it was for sodium oxide. This was possibly because the melting point was relatively low which would be more common for a simple molecular structure. This often led to discussion involving intermolecular forces which, in common with Q7(b), would often undermine the whole response. In spite of candidates not identifying structures, there was often good knowledge of electrostatic attraction between ions and delocalised electrons, and between oppositely charged ions respectively. Even where candidates failed to use technically accurate terms, responses often showed recognition that the strength bonding or the energy required to break the bonding was behind the large difference in melting points.

(d) The table shows the melting points of sodium and sodium oxide.

		melting point in °C
Na	sodium	98
Na_2O	sodium oxide	1132

Explain why sodium and sodium oxide have different melting points.

In your answer you should refer to:

- the structures of sodium and sodium oxide
- the forces between the particles.

(5)

Na has giant metallic structure
Na has metallic bonds
~~Attraction between~~
Na_2O has giant ionic structure
Na_2O has ionic bonds
Electrostatic attraction between positive ions and delocalised electrons in Na needed less energy to overcome
Electrostatic attraction between positive ions and negative ions ~~need~~ in Na_2O needed more energy to overcome.

Principal Examiner comment:

This response scores all 5 marks. The different structure types for both substances are clearly identified at the start of the response. The candidate identifies the electrostatic attraction between the correct types of particles for both sodium and for sodium oxide. The relative amount of energy required to overcome the electrostatic attraction is consistently referred to. Candidates should be encouraged to use comparative wording such as "more" and "less" to ensure that they have fully answered the question.

Explain why sodium and sodium oxide have different melting points.

In your answer you should refer to:

- the structures of sodium and sodium oxide
- the forces between the particles.

(5)

The structure of sodium is not a lattice structure. It has a small molecular structure while sodium oxide has a giant ~~lattice~~ ionic structure. Sodium has weak intermolecular forces and sodium oxide has strong intermolecular forces so it requires more energy to break the bonds

Principal Examiner comment:

This response scores 1 mark. The structure type is correct for sodium oxide but incorrect for sodium. There is consistent referencing to intermolecular forces in both structures, which negates the point about energy and bonds.

Question 8

This question was about testing for chlorine, a reversible reaction involving chlorine, the changes to reverse the reaction, the effect of temperature on the rate of reaction, and calculation of percentage yield for the reaction.

Q8(a)

Most candidates were able to give the test and result for the identification of chlorine. Where a candidate did not score both marks, it was normally for an imprecise answer such as the omission of “damp” litmus paper. The most common incorrect answer tended to be when the test was confused with the test for the chloride ion.

Q8(b)

The majority of responses showed the symbol for a reversible arrow, but the formulae of the substances were not always correct (e.g. molecular chlorine) or should not present (e.g. molecular iodine). State symbols were dependent upon the formulae being correct or recognisable. The most common error was the use of the aqueous state symbol.

Q8(c)(i) and **(ii)**

Both questions saw most candidates score at least one mark. In part (i), the majority of responses suggested heating the crystals or removing the ice.

In part (ii), many candidates were able to identify that the starting point of the observation involved the crystals disappearing or melting, which followed on from part (i). Candidates often correctly indicated that this change resulted in a brown liquid. The production of more green gas was usually only mentioned as an additional observation in better responses rather than as an alternative suggestion. When candidates did not score this was usually because names or formulae were referred to rather than observations. Other errors included that changes in conditions were discussed or the observed change was given the wrong way round.

(ii) Describe what would be observed during the reverse reaction.

(2)

~~A yellow crystal is formed after 16 minute~~

The colour of chlorine gas out is getting paler overtime because most of the chlorine gas is used to make ICl_3 which is a yellow crystal.

Principal Examiner comment:

This response scores 0 marks. The answer is not entirely clear but would suggest that chlorine gas is reacting to make iodine trichloride, which would be the wrong direction. Despite the focus upon the identities of substances, the description of the observation would be good for the forwards reaction.

Q8(d)

A range of marks were awarded to responses for this question. Despite the question being about the effect of ice on the rate of the reaction, some candidates attempted to explain the effect upon the direction of the reversible reaction. However, most candidates were able to identify that ice would reduce the rate of reaction, explaining that particles would have less energy and that less frequent collisions would occur. When candidates lost marks for this correct approach it was usually because either particles and/or the frequency of collisions was not referred to. Only the best responses remembered to link the use of ice to a lower temperature in comparison with room temperature.

Q8(e)

This question was generally well answered by candidates, with many scoring all 3 marks. A common error was initially to calculate the relative molecular mass for the wrong formula e.g. ICl rather than ICl_3.

Question 9

This question was about the physical properties of halogens, a reacting mass calculation, and the interpretation of a series of displacement reactions to determine which halogen was present in a solution.

Q9(a)

In this multiple-choice question, many candidates were able to apply their understanding of the colour trend in group 7 to identify the halogen with the palest colour as being fluorine.

Q9(b)

This multiple-choice question required some data analysis. Many candidates identified option C as the correct option - the melting point was above room temperature, but the boiling point was below the maximum temperature from a Bunsen burner flame.

Q9(c)

Candidates that attempted this calculation were typically able to determine the amount of moles of bromine being used. More commonly, candidates were able to score at least 2 marks and very clear working was seen. Full marks was often not scored because the stoichiometric ratio shown in the equation had not been applied.

Q9(d)

The question met with mixed responses from candidates, with a range of marks being awarded. Candidates were aware from the context that this question was about halogens and displacement, but some did not appreciate that this was limited to chlorine, bromine and iodine. Many candidates set about discussing the results but did not have a clear line of interpretation to follow. Candidates that correctly identified the trend in reactivity for the halogens at the start of their response would gain a mark if correct, and this often led to further marks. It was rarer for candidates to also state that halogen colours became darker down the group. Many were unable to clearly state how a darker colour change indicated that displacement had taken place, which was key to interpreting the results. This could sometimes be awarded within a candidate's explanation of the results. A common misconception was that because a more reactive halogen was paler in colour, a result with a paler colour change indicated a reaction. It was often the case that candidates made assumptions that a darker colour meant a specific halogen, such as bromine. In spite of whether knowledge of the trends of the halogens was shown or not, it was the case that many candidates did give a good rationale for identities of solutions, based upon the number of similar colour changes or an order of reactivity with halides. The only weakness here tended to be whether there had been a full consideration of solution X / bromine, as there was sometimes just reference to the reaction with potassium iodide and no clear acknowledgement of there being no reaction with potassium chloride.

Explain how the results show which halogen is in solution X, which halogen is in solution Y and which halogen is in solution Z.

In your answer, refer to:

- what the colour change indicates
- the order of reactivity of the halogens.

(6)

Because , solution Y can't react with all solution and can't displace all elements so it has the leatest reactivity.
Solution X ~~can't~~ react with potassium iodide solution so it can displace I , its ~~n~~ reactivity is bigger than I
Solution Z can react with KBr and KI displace Br , I so its reactivity is bigger than Br, I
reactivity Cl > Br > I
~~Because~~. ~~Cl~~ ~~react~~ solution X is Br solution Y is I , solution Z is Cl ~~the color of Cl is the palest~~, add KCl, color turns paler, add KBr solution ~~Z~~ Cl turns darker. add KI solution, solution ~~X~~ Br and ~~Z~~ Cl turns darker.

Principal Examiner comment:

This response scores 3 marks. The candidate has immediately started with an interpretation of the results for each solution. The interpretation has some logic but is only just coherent. The order of reactivity of the halogens is only established later and then the correct identification of the solutions follows this. However, there is no clear statement about what a darker or paler colour signifies. The rationale for the identities of solutions Y and Z is acceptable, but this is only partially given for solution X and so marking point M4 has not been awarded.

Explain how the results show which halogen is in solution X, which halogen is in solution Y and which halogen is in solution Z.

In your answer, refer to: (→ ordered in each solution. 3 at a time.)

- what the colour change indicates
- the order of reactivity of the halogens.

(6)

Solution X. is Bromine, Solution Y is Iodine and solution Z is Chlorine. ~~Reactive~~ whereas, Chlorine is most reactive and iodine is least reactive, solution X, (1) Bromine has no effect on ~~chloride solution~~ potassium chloride solution, Bromine cannot displace itself (2) so doesnt take place. Bromine displaces iodine from potassium iodide. the solution turns brown. Secondly, Solution Y, Iodine has no effect on potassium chloride nor potassium ~~iodide~~ bromide. and obviously iodine cannot displace itself in potassium iodide solution. so it doesnt take place. Finally, Solution Z which is chlorine, at start it chlorine cannot displace itself in potassium chloride solution. and chlorine displaces both potassium bromide and iodide. the solution turn orange ~~for potassium~~ when Chlorine displaces bromine. ~~and~~ and turns brown when chlorine displaces iodine.

therefore, the solution ~~p~~ turns pale circle indicates, the reaction didnt happen ~~or~~ as it cannot displace itself or is lower than the other element in reactivity series. and the solution turns darker circle indicates it ~~either~~ or it displaces the other element successfully and changes color of solution.

(Total for Question 9 = 11 marks)

Principal Examiner comment:

This response scores 5 marks. The candidate has begun by correctly identifying the three solutions and indicates the most and least reactive halogen, which is reinforced throughout the response. The identity of each solution is then carefully justified, result by result. The response concludes with a good account of what pale and dark circles mean in terms of whether a reaction has occurred or not and why. All that is missing here is some comment to link halogens further down the group (or less reactive halogens) being darker in colour than those that are higher (or more reactive).

Question 10

This question was about the use of acidified potassium dichromate (IV) solution to distinguish between ethanol and ethanoic acid, practical considerations when making an ester, naming and drawing esters, and calculation of the mass of unreacted carboxylic acid.

Q10(a)

Many candidates found this particular question challenging, which did require some clear identification and careful reasoning to support the answer. Responses revealed that the exact colour change of acidified potassium dichromate (VI) during an oxidation was only known by a proportion of the cohort, with many suggesting all types of colour changes. Even where the correct colour change was identified, it was unclear when it occurred and was often incorrectly attributed to ethanoic acid.

(a) Acidified potassium dichromate(VI) solution changes colour when it oxidises another compound.

State the colour changes that occur, if any, when acidified potassium dichromate(VI) is added to separate samples of ethanol and ethanoic acid.

(2)

Colour Change is from orange to green

Principal Examiner comment:

This response scores 0 marks. Whilst the colour change observed when potassium dichromate(VI) reacts is correct, there is no indication of whether this is with ethanol or with ethanoic acid.

State the colour changes that occur, if any, when acidified potassium dichromate(VI) is added to separate samples of ethanol and ethanoic acid.

(2)

When acidified potassium dichromate (VI) is added to ethanol, colour changes from orange to green.

if added to ethanoic acid, no colour change occur.

Principal Examiner comment:

This response scores full marks. The colour change has been correctly given with ethanol, with clear indication that there would be no colour change with ethanoic acid.

10(b)(i) and **(ii)**

These parts of the question explored candidate understanding of the safety issues surrounding an experimental procedure to make an ester. Whilst precautions were well known, specific hazards were not so well explained, so candidates often only scored a couple of marks.

In part (i), most candidates were able to propose an appropriate item of protective clothing to wear. Fewer were able to identify that concentrated sulfuric acid or carboxylic acids used in the experiment would be corrosive.

In part (ii), many candidates identified ethanol being flammable was the reason to use a hot water bath. Few were able to identify that heating using a Bunsen burner flame would be much hotter than a water bath and would increase the risk of ignition.

Q10(b) would suggest that hazards and risks involved in making esters are not well known by candidates. Centres are advised to focus more closely upon this part of the IGCSE Chemistry specification.

10(b)(iii)

In this multiple-choice question, many candidates correctly identified "fruity" as being one of the distinctive smells associated with an ester.

10(b)(iv)

This question required candidates to be able to identify and correctly name the ester from its structural formula and was intended to challenge candidates. Relatively few were able to attempt the question, with only the best candidates able to give the correct answer. Incorrect answers included the names of carboxylic acids and occasionally chemical formulae. Answers that were incorrect but were esters tended to either reveal specific learning (i.e. ethyl ethanoate) or an incorrect application of naming (i.e. propyl ethanoate). Candidates should be advised of the necessity of accurate spelling in organic names or risk losing the mark (e.g. propanoate rather than propenoate). Occasionally, a candidate's response could be seen to apply some form of working which assisted them, such as a displayed formula or dividing the structural formula up in to sections, which is encouraged.

(iv) One ester has the structural formula $\underbrace{CH_3CH_2COO}_{\text{Propanoate}}\underbrace{CH_2CH_3}_{\text{ethyl}}$

Name this ester.

(1)

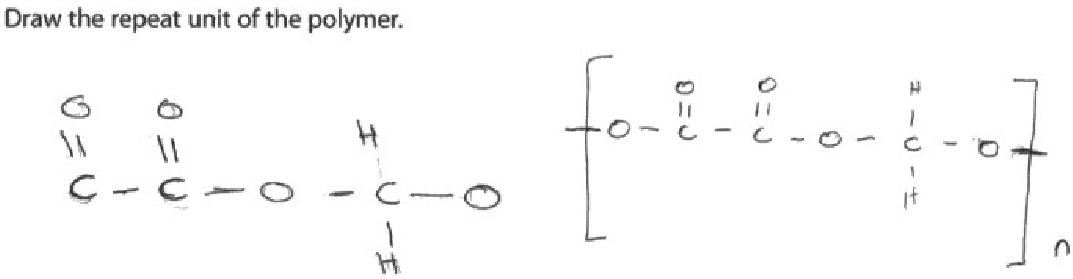
ethyl propanoate

Principal Examiner comment:

This response scores 1 mark. The structural formula has been considered in sections by the candidate who has correctly identified the carboxylate part of the name and the name of the prefix.

10(c)

This question required candidates to draw the repeat unit of a condensation polymer and was again intended to challenge candidates. Responses that did not score anything tended to show flaws in understanding of how to draw organic molecules or did not appreciate what type of reaction was occurring. Responses that scored only one mark were often for a structure that was an ester but showed an error, usually at the ends of the structure. Only the best candidates were able to draw the structure with sufficient accuracy to achieve both marks. These were often accompanied with good knowledge of the reaction (e.g. water as a byproduct) and some form of working. As for 10(b)(iv), candidates should be encouraged to approach such problems with a strategy to work out the answer.

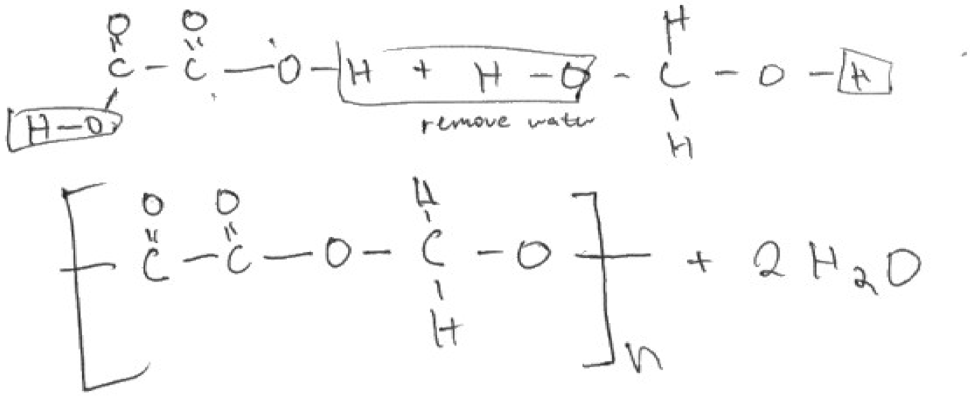


Principal Examiner comment:

These responses both score 1 mark as both formulae show the ester group.
However, the first diagram does not show extension bonds at either end of the molecule, which are needed to suggest that it is a polymer. The second diagram has an oxygen atom at both ends of the molecule which is not the correct repeat unit. The inclusion of brackets and n is not necessary in this particular question, as the repeat unit has been asked for rather than a general formula.

Draw the repeat unit of the polymer.

(2)



Principal Examiner comment:

This response scores both marks. The displayed formula of the polyester matches the diagram shown in the mark scheme, although there are other ways in which the structure could be displayed that would be acceptable (e.g. the oxygen atom at the other end of the molecule). The response is noteworthy as the candidate has shown their "working" which is to remove water molecules from the two reactants and combine them to give the displayed structure. This demonstrates a good understanding of the reaction. The number of water molecules that are "formed" are ignored as the focus of the question is upon the polymer.

Q10(d)

This final question tended to discriminate well between those candidates that were good and those that were the very best. Weaker candidates were often unable to make a start, but candidates that knew how to calculate moles from volume and concentration were normally able to secure the first two marks, although this was dependent upon volume conversion into dm^3. The most challenging part was appreciating that the carboxylic acid was in excess and calculating the remaining moles. Many candidates were unsure how to achieve this next step, but even those that did would often forget that the stochiometric ratio had to be taken into account. The last step was relatively routine, converting moles into a mass, and was an accessible mark even if the previous step had not.

(d) This is the equation for the reaction between ethanedioic acid and sodium hydroxide.

$$HOOCCOOH + 2NaOH \rightarrow (COO)_2Na_2 + 2H_2O$$

A beaker contains $30\,cm^3$ of $0.40\,mol/dm^3$ ethanedioic acid solution.

A student adds $70\,cm^3$ of $0.20\,mol/dm^3$ sodium hydroxide solution to the ethanedioic acid.

After this addition, the ethanedioic acid is not fully neutralised. Exces

Calculate the mass of ethanedioic acid that remains in the beaker after the reaction.

[for ethanedioic acid, M_r = 90]

(4)

ethanedioic Acid NaOH

mol $\frac{30}{1000} \times 0.40$ $\frac{70}{1000} \times 0.20$

$= 0.012$ $= 0.014$

ethanedioic Acid : NaOH

1 : 2

$\frac{0.014}{2} \times 1$ 0.007 0.014

Neutralized = 0.007

Total = 0.012

0.012 − 0.007

Remaining = 0.005

Mass = mol × mr

0.005 × 90 = 0.45 g

mass = 0.45 g

Principal Examiner comment:

This response shows very clear working of the correct answer and scores all 4 marks.

Summary

Based upon performance within this paper, it is recommended that candidates:

- use chemical terminology more often and with greater accuracy, such as when explaining the effect of structure on physical properties
- use comparative words or links within explanations where a question indicates that two substances or two conditions are being considered
- develop logical explanations for extended response answers
- understand or provide the reasons for steps in practical work, particularly investigations specified in the specification content
- know exact observations for standard tests and reactions, and be able to describe these fully
- practice non-routine calculations which involve additional steps, such as stochiometric changes and excess reactants
- know the principles and conditions necessary for electrolysis
- be able to recall ion charges, use these to write formulae or deduce them from given formulae
- be able to combine different pieces of information and knowledge to solve a problem, such as the use of chemical tests or other reactions to identify a formula or substance.

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom