Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2022

Pearson Edexcel GCE
In Chemistry (8CH0)
Paper 01 Core Inorganic and Physical Chemistry

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Introduction

(i) Legibility

Students should be aware that examiners will be unfamiliar with their writing and may struggle with poor grammar, unconventional spellings, and illegible writing. Although examiners will always do their best to decipher a difficult presentation, it would be unfortunate if these factors caused the student to lose marks.

(ii) Calculations

These can be difficult for examiners to mark if the student scatters numbers across the page with little or no explanation. Students are advised to write a few words explaining the logic of their calculations. This makes it much easier for examiners to identify any errors and to give credit for any consequential inaccuracies.

Examiners will always give some credit for calculations that are in error, provided that they can see where the calculation has gone wrong.

(iii) Allocated response space

The area for a response is carefully delineated in the exam paper. If the response goes outside this area there is a danger that the scanning process will miss it and the examiner will not see it. In particular, students should not write outside the lined boundary because their answers may not be seen.

Should the student wish to continue with an answer, this should be on additional answer sheets and **not** in vacant spaces on the question paper. If an answer is continued elsewhere, it is a good idea to indicate on the allocated space on the question paper where the written response continues and is to be found.

(iv) Crossing out

Students frequently change their minds about the validity of their answers. Any crossing out should be done with a single line through the answer that is not required.

Examiners are required to read (or attempt to read) any answer that is not replaced by another answer. This becomes impossible if an answer if heavily deleted.

There are many reasons why a deleted answer may not be replaced; lack of time, unable to think of a better answer, etc. So, it is important that the original answer is still legible.

(v) Spelling

Examiners will often encounter unusual spellings. Provided that the meaning of the word is not changed, or it does not change the meaning of a sentence, credit will be given. However, students should be very careful with technical terms, and it is advisable to ensure the correct spelling of these words, e.g., phenolphthalein (phenylphthalein would not be acceptable).

(vi) Use of fractions

Fractions are sometimes more accurate than decimals. However, examiners will expect to see decimals. And students are advised to use decimals in their calculations (with a sufficient number of decimal places to retain accuracy).

(vii) Rounding v Truncation

Students should learn how to round numbers. This is a technical subject and truncation of numbers introduces an inaccuracy that can be easily avoided, e.g., in this paper, one route for the calculation in Q9a gives an answer of 1666.67 kg, this rounds to 1667 kg not 1666 kg (which would be produced by truncation of the number)

(viii) Highlighters

Students are permitted to use highlighters on the questions, but if used on their answers the scanning process causes what is written to be obscured. This might cause an answer that could have scored mark(s) to be unreadable.

Examiners continue to see papers where highlighters have been used on a written response and have obliterated a student’s answer.

Q1 Multiple-choice

This question was designed to be a relatively easy introduction to the paper, only requiring knowledge of the maximum number of electrons in subshells. Nearly all students responded to this question correctly.

Q2 Multiple-choice

This question was also designed as a relatively easy introduction to the paper, requiring students to relate significant changes in ionisation energy to group number. Most students responded to this question correctly.

Q3(a)

This question required students to identify 3 errors in a written passage about the processes that occur in the production of flame colours. A good selection of correct responses was seen. Throughout the total scripts seen, all three correct responses appeared, although occasionally the response referring to the appearance of radiation in the visible region, was duplicated.

Q3(b) Multiple-choice

This question required only knowledge of the flame colours of some metals. Nearly all students correctly identified sodium iodide as the only compound of those listed that does not give a red flame test.

Q3(c) Multiple-choice

This question required only a knowledge of the suitability of some metals as flame test wires. Nearly all students correctly identified platinum as the correct response, the other metals giving either a flame colour or are themselves too reactive (magnesium). Just a few students thought copper was suitable but this gives a flame colour (blue-green) and would also melt in a hot Bunsen flame.

Q3(d)(i)

This question continued the relatively straightforward introduction to the paper, requiring the **name** of a suitable reagent to identify the anion in potassium bromide. Although the name (silver nitrate) was specified by the question, a correct formula was also accepted. However, students should beware this, in some past papers that specified the name, the formula would have been unacceptable. Chlorine was an acceptable alternative to silver nitrate, but with different results in (d)(ii). Concentrated sulfuric acid, although a possible answer, was not seen.

Q3(d)(ii)

Students found this more challenging. For the result of the test, both words (cream precipitate) were required; some thought that a white or yellow precipitate was produced.

The formula of the product also presented a challenge, with $AgBr_2$ seen on several occasions.

Q4(a) Multiple-choice

This question was about the number of subatomic particles in an atom of a less well-known isotope of hydrogen, ^{3}H. The mass number was provided but students were expected to know (or look up) the atomic number of hydrogen. The question was therefore an exercise in the use of data rather than purely an act of memory.

Q4(b)(i)

This question on mass spectrometry involved the calculation of the peak height of an isotope of chlorine (^{37}Cl), given the peak height of the only other isotope present (^{35}Cl). Students first needed to calculate the relative abundance of ^{37}Cl, and then calculate the ^{37}Cl peak height from the height of the ^{35}Cl peak provided.

Some students got this completely correct while others had little idea of how to proceed. Many realised that they would need the relative abundance of ^{37}Cl and were given credit for this.

Q4(b)(ii)

Nearly all students realised that the peaks at 70, 72 and 74 had something to do with the isotopes of chlorine but a substantial number then failed to explain why the peaks were at 70, 72 and 74.

Q04(b)(iii)

This was the first really challenging calculation of the paper. A pleasing number of students provided well-reasoned answers based on probability and were awarded maximum marks. Other students just provided a random array of figures with no explanation as they attempted to arrive at the correct ratio.

Since there are several different routes to the final answer, a few words to explain the calculations would have been very useful.

A common error was to fail to multiply by two for the probability of a molecule consisting of ^{37}Cl-^{35}Cl or ^{35}Cl-^{37}Cl. This factor was frequently ignored with a ratio of 9:3:1 claimed to be 9:6:1.

Q04(c)(i)

This question required students to recognise that the peak furthest to the right is the parent ion peak. Some confused the tallest peak (i.e., greatest abundance) with the parent ion peak.
Others appeared to sacrifice this mark to get a mark in 4(c)(ii), citing molar mass that corresponded to a minor peak in the mass spectrum. – see comment below, in 4(c)(ii).

Q04(c)(ii)

The correct hydrocarbon $C_{12}H_{26}$ required a valid response to 4(c)(i), thus this mark was awarded for any molecule that corresponded to the molar mass provided in 4(c)(i). However, some answers included implausible hydrocarbons, eg C_4H_9 = 57. Others were only correct if the suggested molecule contained multiple double or triple carbon-carbon bonds. While credit was given for such answers, most students would be unfamiliar with such molecules, and in some instances, the response was perhaps just a fortunate guess.
Alkanes and alkenes are both possible provided the appropriate molar mass was given in 4(c)(i).
There was a suspicion that a few students had suggested implausible molar masses in 4(c)(i) in order to write a familiar known hydrocarbon here in 4(c)(ii)

Q04(d)

This was intended to be a straightforward calculation of the empirical formula of a hydrocarbon.
A relatively common error was the omission of x2 for the conversion of moles water to moles hydrogen. However, provided that the rest of the working was clear, credit was given for the remainder of the calculation.
A few students seemed convinced that the molecule must contain oxygen, ignoring the question that twice states that **W** is a hydrocarbon.
Several creditworthy alternatives routes to the final answer also exist, but all require a modicum of explanation to explain the logic of the calculation.

Q5(a)

This question required the student to identify a melting temperature trend from the data provided and also to recognise that hydrogen bonding would not be significant factor in the melting temperature of HI, as it is for HF.

Q5(b) Multiple-choice

This question required students to recognise the effect of branching and the shape of molecules generally on boiling temperatures. The structure of the

target molecule was provided to avoid testing the ability to relate names to structure in the same question.
Some answers implied that some students had been seduced by the similarity in the boiling temperatures of the isomers shown in the table. The effect of branching had been ignored in these responses.

Q5(c)

This question was the free response item in this paper. As expected, it provided a wide range of marks, ranging from those who chose not to attempt it to well-constructed answers that were awarded full marks. Given the length of the typical response to this item, legibility was a significant factor in some scripts.

The question tested the student's ability to recognise when hydrogen bonding can occur and the ability of ionic compounds to dissolve by forming hydrated ions in water.

Some students failed to provide diagrams in spite of an instruction to do so and space that had clearly been provided on the paper. Many scored IP1, recognising that hydrogen bonding occurs between water and methanol. For IP2, the diagram of hydrogen bonding required a clear approximation to bond angle for the H-bond, or an equivalent statement in the text. This was absent from some responses – usually the diagram was inaccurately drawn. Some students thought, erroneously, that the hydrogen atoms in methanol's methyl group could take part in hydrogen bonding. IP3 related to a comparison of the strength of bonding in methanol and water and a mixture of the two, or to a statement of hydrogen bonding in methanol and water separately. IP3 was less commonly scored. IP4 and IP5 related to the solvation of sodium and chloride ions. The terms 'solvation' or 'hydration' were rarely used but there were sometimes accurate descriptions, however there were many acceptable diagrams. IP6 required an explanation, in terms of the relative strength of bonding, of why sodium chloride is relatively insoluble in methanol. This marking point was rarely scored.

Students should be aware that a dotted line conventionally means a hydrogen bond, similarly a solid line conventionally means a covalent bond; in this question a line between Na and Cl implies a covalent bond.
In general terms, relatively few answers were well constructed. Many were a jumble of ideas, lacking continuity and, in several scripts, the writing was very difficult to read.

Q6(a)

This question proved to be surprisingly difficult for the majority of students. Many were uncertain about the structure of all three substances. The bonding in potassium chloride was usually correct but occasionally thought to be covalent.

By far the most common error was in the structure of iodine, which was often identified as just 'simple', rather than 'simple molecular' or 'molecular'. A greater emphasis on the correct descriptive terms for structure is recommended.

Many scored just 1mark for 2 or 3 correct responses. Two marks required all four responses to be correct.

The word 'giant' was frequently mis-spelled as 'gaint', in spite of the fact that the word was already present in the question for the structure of silicon(iv) oxide.

Q6(b)

This question required students to relate the structure of silica and iodine to the relative size of their melting temperatures.

M1 was related to the number of bonds in silicon dioxide that must be broken when it melts. Many answers were focused only on the relative strength of the bonds that must be broken.

M2 required students to identify weaker bonds (London forces) bonding the iodine molecules to each other. Many answers related only to the bonding between the iodine atoms in the molecule, ie covalent bonds.

M3 required the concept of energy (to break bonds); most of the answers that scored this point then also related energy requirements to melting temperature.

Q6(c)

This question expected students to contrast the electrical conductivity of iron with that of potassium chloride in both the solid and the molten states.

Many erroneous answers thought that the charge conductors in molten potassium chloride were electrons, whereas it is the ions that move.

These answers often also postulated that solid potassium iodide failed to conduct because the electrons are unable to move, whereas it is the ions that are unable to move in the solid state.

Mention of delocalised electrons in iron was required to score the mark.

Good answers then went on the record that delocalised electrons are present in iron in both the solid and liquid states, so both states conduct electricity.

Q7(a) **MCQ**

This multiple choice question required an understanding of the periodic table in terms of s, p and d-block elements. To that extent, it also required an understanding of the electronic configuration of elements. Most students were successful in this question.

Q7(b)

This was a simple recall question concerned with the solubility of hydroxides and sulfates down group 2. Students could get a good indication of these trends by remembering the appearance of lime water (calcium hydroxide) during a test for carbon dioxide, and the test for sulfate using barium chloride ($BaSO_4$ precipitates).

Q7(c)(i)

Most students struggled with this dot-and-cross diagram, although it was made easier by allowing diagrams with all dots/all crosses etc. However, students should be aware that examiners will sometimes require the origin of the electrons to be identified.
Common errors:

- absence of any double bond
- inclusion of two or three double bonds, ie to more than one oxygen atom.
- absence of non-bonding electrons on one, two or three oxygen atoms
- some (usually two) nitrogen electrons not involved in bonding
- absence of the 'extra' electron (which should be present because the nitrate ion is negative)

Q7(c)(ii)

Students were asked to write an equation for the thermal decomposition of lithium nitrate. This decomposition is similar to the thermal decomposition of Group 2 nitrates (and different to the rest of the Group 1 nitrates). This information is essential to the formula of lithium oxide and hence the rest of the balanced equation.
Some students appeared to be uncomfortable with the concept of $\frac{1}{2}O_2$ and preferred to double the equation; this was perfectly acceptable.
Some attempted to use an incorrect formula for lithium oxide (usually LiO or LiO_2). An incorrect initial formula for lithium oxide negated the mark (because the equation could not be balanced correctly).
Students should be reminded of the importance of caps for element symbols, e.g., lithium is Li not li.

Q7(c)(iii)

This was a relatively straightforward gas volume calculation involving the ideal gas equation (which was provided).
Most students successfully calculated the moles of sodium nitrate, although an incorrect molar mass for sodium nitrate was seen on several scripts.
The ratio between moles of sodium nitrate and oxygen gas was ignored by many, leading to an answer that was double the correct value.
Nearly all students were able to rearrange the ideal gas equation correctly and substitute the relevant values, (many using the incorrect moles of oxygen).
Many students lost M4 because they failed to give the final answer to 2 SF, as instructed. Or because the ideal gas equation gives an answer in m^3 and students were instructed to calculate their volume in cm^3, and they failed to convert correctly (if at all).
This calculation provided an excellent example of the need to lay out calculations clearly; even those who used an incorrect molar mass of sodium nitrate at the outset could still score the remaining three marks provided their working was clear and there were no more errors.

Q7(c)(iv)

In this question the students were asked to suggest a reason why the experimental gas volume differs from the theoretical volume.
Clearly, many students have experience of practical situations in which the theoretical volume was not achieved. Many of the more obvious experimental errors were excluded by the question or by the rubric in Q7(c)(iii). However, these specific reasons were cited in a significant number of scripts.
Students should not suggest side reactions unless they are quite sure that such reactions could occur.
Other students lost the mark because they had suggested two reasons and the acceptable answer was the second listed, or the two answers contradicted each other. It is always advisable to check the mark allocation for a question; 1 mark usually means only 1 idea required (Q8(b)(i) was an exception to this general idea). If the student decides to give a second idea, they should ensure that it is correct.

Q7(d)

This question proved to be challenging for many students.
M1 Many responses claimed that group 2 carbonates have a greater charge than group 1 carbonates, when the response should have referred to the group 1 and 2 **ions.** Similar considerations were applicable to

descriptions that discussed charge density of the group 1 and group 2 carbonates**.**
M2 although many had realised that the thermal stability had something to do with the charge on the ions (with some erroneously claiming it was the carbonate ion). Relatively few recognised the effect of the cation charge on the polarisation of the bonds in the carbonate ion. References to the distortion of the bonds in the carbonate were also accepted.
M3 fewer still commented that the C-O bond in the carbonate would be weakened.
Occasionally responders became distracted and instead discussed the trend in thermal stability down the group.

Q8(a)

This calculation to find the number of molecules in a volume of gas was answered well, the majority of students arriving at the correct final answer.
The most common error was the use of an incorrect initial volume of gas (usually 20cm^3), ie an incorrect use of the equation which shows that 40 cm^3 of HCl (g) product is produced. For M1 the correct volume of gas is then converted to moles using the molar gas volume provided.
M2 is then scored by correct application of the Avogadro number.
Again, the importance of clear working is paramount in this calculation. Examiners might have been able to award M2 even if the moles of gas had been incorrectly calculated.
Students should be aware of the possibility of rounding errors in this calculation: $40 \div 24000 = 1.67 \times 10^{-3}$, not 1.66×10^{-3}
Sufficient figures should be retained during calculation to ensure that the accuracy of the final answer is not influenced.
Finally beware of transposition errors. The final answer in this calculation is 1.0033×10^{21} not 1.03×10^{21} as was seen in several scripts.

Q8(b)(i)

This question was, inexplicably, poorly answered by the majority of students. Students tended to answer half the question, either why hydrochloric acid conducts or, less successfully, why hydrogen chloride gas does not conduct electricity. The other half of the question was then largely ignored.
There were many good answers giving reasons why hydrochloric acid conducts electricity. However, there were also a substantial number of responses that claimed the conducting particles to be electrons rather than ions.
The lack of conductivity shown by hydrogen chloride gas was largely ignored. A few students noted that the particles are distanced from each

other in a gas, but very few answers correctly identified the lack of mobile charged particles in hydrogen chloride gas. Some thought that the gas phase contains either delocalised electrons or ions.

Q8(b)(ii)

A surprising number of students were unsure of the formula of ammonium chloride.

A substantial portion of answers included hydrogen gas as one of the products plus a second product containing the remainder of the atoms. These responses failed to score either the equation mark or the states mark.

Just a few responses included ammonia in the liquid state, which was also incorrect. The reactants were usually present either as gases or, less likely, aqueous solutions; both were acceptable.

Q8(b)(iii)

Most students scored at least 1 of the 2 available marks in this question, usually identifying effervescence (some responses gave one of the listed alternative terms for a gas evolved in solution: fizz, bubbles etc.)

However, carbon dioxide given off is a conclusion **not** an observation.

The second mark (for disappearance of the solid sodium carbonate) was scored more infrequently. Many incorrect responses claimed the appearance of a precipitate.

Q8(b)(iv)

This question was correctly identified by many students as a question about titrations.

M1 was scored for placing either the acid or the alkali in the burette and a measured volume of the other solution in a suitable container, (strictly this should be a conical flask but, on this occasion, some other vessels were allowed). For future reference, students should not suggest the use a volumetric flask in place of a conical flask.

It was expected that the measured volume would be introduced from a pipette (volume specified), a measuring cylinder being insufficiently accurate. Many answers omitted the use of the pipette, thus losing M1.

M2 was awarded for a use of a named indicator (usually phenolphthalein or methyl orange) including the correct colour change (which depended on which solutions were used in the burette and pipette respectively). This mark was scored less frequently. A substantial number of students claimed the reverse of the correct colour change, others mixed up the colours of the two different indicators.

The use of universal indicator/litmus was rarely suggested.

M3 covered the addition of solution from the burette into the flask until the end point (when the indicator changed colour). An incorrect (or reversed) indicator colour change was not penalised a second time.
M4 was awarded for any of the procedure that enhanced the accuracy of titrations (white tile, swirling to mix etc.)
M5 covered the use of repeat titrations to improve the overall accuracy of the procedure. The majority of responses included a mention of repeats.

Q8(c)(i)

This question asked students to derive a half equation from a full equation. Many students struggled with this question and their equations frequently included extraneous other species, e.g., MnO_2 or $MnCl_2$.
Some seemed to be unsure of what is meant by the term 'half-equation'.
Many of the correct responses showed the equation doubled, which was also acceptable, i.e., starting with $4Cl^-$ from the 4HCl shown in the given equation.
A relatively common error was to **add** electrons to chloride ions.

Q8(c)(ii)

The format of this question appeared to discomfort some students, in that the question expected a comparison with a specified quantity. Without this comparison the final mark could be lost.
Most students calculated the moles of HCl and from that the moles of Cl_2 produced. This in turn gave a volume and a % yield that could be compared with the expected yield. Just a few students preferred to work in dm^3 rather than cm^3, which was acceptable.
There are several alternative calculation routes to this problem, including the conversion of the 70 cm^3 to moles and then comparison with the theoretical yield (in moles). All received due credit although some calculations required extensive investigation to deduce the student's line of reasoning. A few words to explain the calculations would have been most valuable.

Q8(d)(i)

This question provided an equation and then asked students to explain why this could be classified as a disproportionation.
Most students knew the meaning of disproportionation but occasionally there was an error in the allocation of oxidation numbers to chlorine. Most commonly the error involved the oxidation number of Cl in $NaClO_3$, where it was sometimes claimed to be +1.
In many answers the oxidation numbers were shown on the equation in the question. Provided the allocation of oxidation numbers to chlorine was clear, this was acceptable.

Q8(d)(ii)

In some instances, the molar masses were not separated from the use of multiples and the response so the question became worthy of three marks or zero. In other incorrect responses, the numbers used enabled examiners to decide if the problem lay with the molar masses or the multiples and hence award marks accordingly. However, some solutions were presented as a scattering of numbers with little or no explanation; in such instances it is difficult for examiners to give credit in calculations that do not yield the correct final answer.
The correct answer was available using either the correct molar mass of reactants or products (including appropriate multiples).

Q9(a)

A few students were clearly unfamiliar with this type of calculation and either did not attempt it or their answers were correspondingly incomplete. However, the majority of students were able to complete this calculation successfully. Many used the moles of carbon to calculate the masses of carbon monoxide and hydrogen separately and then add the two masses; a perfectly acceptable route to the correct answer. Of those who arrived at an incorrect answer, the problem was frequently caused by an incorrectly placed decimal point, leading to an incorrect mass of (usually) hydrogen. Hence the addition yielded an incorrect answer.
Most students converted the mass of steam to g, which is the recommended approach to the calculation. However, provided the final answer is specified in kg, the use of 1000/18 can still produce a correct answer, although the moles of water are strictly, Mmoles, not moles.

Q9(b)

The majority of students identified carbon dioxide as one of the products of combustion and therefore the conclusion that 'lime water turns cloudy' was an appropriate response. Hence most students scored these two marks.
Relatively few students recognised 'anhydrous copper sulfate turns blue' as a suitable test for water. Some responses identified anhydrous copper sulfate as a dehydrating agent rather than a test for water. A substantial number of responses identified hydrogen as a second combustion product and therefore attempted to test for hydrogen instead of water.
Very few students proposed to reorganise the equipment such that the 'U' tube was placed before the boiling tube; responses that recognised that water from the lime water test could be mistaken for water as a combustion product of water gas, were seldom seen.

This question proved to be very challenging for students but, placed as the final question on the paper, it was designed to make the most able students pause for thought.

Based on their performance on this paper, students should:

- Learn the correct spelling of key technical words e.g., phenolphthalein. An incorrect spelling might change the meaning of a sentence and cost marks.

- Ensure that questions are answered in full, e.g., in this paper Q8(b)(i) was only partially answered by many students.

- Provide a few words of explanation in calculations to help the examiner recognise the line of reasoning. It will take relatively little time and more marks could easily be awarded.

- Not leave any question unanswered. Even a wild guess may prove to be correct and earn marks. There are no marks for blank answer spaces.

- Try to leave time at the end of an examination to check their answers. Many papers contained obvious errors that could, and should, have been corrected before the end of the examination.

- Give priority to those questions where they know they can score good marks or where the question could yield a large number of marks, e.g., Q5(c) and Q8(b)(iv) on this paper.

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