Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel
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In Chemistry (WCH01)
Paper 01 The Core Principles of Chemistry

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General comment

Some excellent work was seen, with good answers to the numerical questions and the organic mechanism. However there was a wide range in the quality of answers. It was surprising to see frequent errors in questions which were expected to be straightforward, such as the difference in electrical conductivity of an ionic and a covalently bonded compound. Some of the organic questions were regularly not attempted, possibly due to time pressure. Learners would benefit from more practice in writing answers where explanations are needed. They are more likely to score high marks when the answer is well organised.

Q19

Learners used a variety of methods to find the mass of the fourth isotope in Q19(a)(i). It was surprising that some learners did not carry out the task of calculating the percentage of the fourth isotope, which is 18.60. The most popular approach was to use algebra to find the mean mass of the isotopes including 18.60 x, where x is the isotopic mass. The answer had to be given to a suitable number of significant figures, so the final answer should have been given as 68.

When answering Q19(a)(ii) it was apparent that many learners did not know that isotopes have the same chemical properties. Even if this was stated many did not know that chemical properties depend on the electron configuration. The less precise answer that properties depend on the number of electrons was allowed. However, learners must make sure that they read questions carefully; some made a correct statement that isotopes have the same atomic number but different mass number without answering the question. Others discussed physical properties, or said that chemical properties would be the same but gave no explanation. A few learners wrote that the isotopes would have similar chemical properties; they need to be aware that "similar" does not have the same meaning as "same".

In Q19(b)(ii) descriptions of the different stages in the mass spectrometer were often given without answering the question. Many learners scored a mark for acceleration occurring but did not refer to the emerging particles being in a beam, or travelling in the same direction.

Many alternatives were allowed for the description of the label on the horizontal axis of a mass spectrum in Q19(b)(iii). The number of wrong answers may explain why learners have trouble interpreting mass spectra. The instruction to use words, not symbols, was usually followed.

The majority of answers to Q19(c) were correct, and the configuration could be given ending $4s^2$ $3d^{10}$ or with all the third shell electrons before the fourth shell.

Metallic bonding was generally well known and many answers to Q19(d) scored full marks. Some learners thought the lattice was made of protons, not ions, and some diagrams had far too many electrons drawn relative to the total number of positive charges shown. A few showed the electrons round the edge of the positively charged particles rather than among them. Nearly all learners knew that there were delocalised electrons in the structure.

Q20

Answers to Q20(a) were divided between those who drew a zig-zag pattern and those who continued the upward trend from silicon to phosphorus. The equation for the second ionisation of aluminium in Q20(a)(ii) was usually given correctly, though learners regularly forgot to include state symbols despite the instruction in the question.

Learners had great difficulty organising their answer to Q20(a)(iii). There were many answers where it was not clear which comparisons were being made, as they did not break the question down into two smaller comparisons (magnesium versus aluminium, and then aluminium versus silicon). Some compared the first and second ionisation energies of each element. Others tried to explain both comparisons together as one and used phrases such as "they all have the second electron removed from the same subshell," which is true for aluminium and magnesium but not for aluminium and silicon. Learners should be encouraged, in all ionisation energy questions, to identify the electronic configuration of each particle before and after ionisation. In this case they would have realised that an electron is removed from 3s in magnesium and aluminium and from 3p in silicon. An extra proton makes ionisation energy more difficult when electrons are in the same sub-shell or have the same shielding, which is why it is harder to ionise Al^+ than Mg^+. Silicon has one more proton than aluminium, but the second ionisation is lower because the electron in silicon is in a higher energy orbital. Many learners ignored the proton number and focussed on whether electrons are in full or half-full subshells.

There were few correct answers to Q20(a)(iv). Argon was the most popular answer but every other element in Period 3 was suggested, as well as elements elsewhere in the Periodic Table. The first thing to consider when predicting ionisation energies is the energy level of the electron being removed, so sodium has the highest second ionisation energy as it is the only element in Period 3 where the electron is being removed from the second main shell.

The answers to Q20(b)(i) were surprisingly poor despite the type of bonding in the two compounds being stated in the question. A common answer was that magnesium chloride had better conductivity than sulfur dichloride. Solid magnesium chloride does not conduct, so the answer needs to include a reference to a physical state, and a description of one clear difference got the mark eg magnesium chloride conducts when molten, sulfur dichloride does not.

Q20(b)(ii) was generally well answered, apart from a few diagrams which included charges. Another common error was to omit the non-bonding electrons on sulfur. Marks were not lost if an x was used for chlorine electrons and a dot for sulfur electrons.

The electron density map in Q20(b)(iii) often showed SCl rather than SCl_2. Learners are not very familiar with electron density maps but diagrams with the contour lines of electron density going round more than one nucleus were seen more often than in recent papers. Some learners just drew the dot and cross diagram again with lots of overlapping circles.

The mark for Q20(b)(iv) was not often scored. Some may have realised that the ions would have discrete contour lines, but the answers were not expressed clearly enough to earn the mark.

A common error in Q20(c)(ii) was the omission of the state symbol for magnesium chloride. Learners should be careful when writing (s) and (g), as many symbol could not be distinguished. The information about the enthalpy change of atomisation of magnesium chloride was given in the format in which it appears in the Data Booklet. This caused some confusion. It is the energy change to convert $\frac{1}{2}Cl_2(g)$ to Cl(g) and therefore needs to be doubled when a chlorine molecule is atomised. The direction of the arrows in the enthalpy level diagram indicate that the last two pieces of data in the table are for exothermic changes. The upward pointing arrows are for the atomisation of magnesium and chlorine and the two ionisations of magnesium, as these changes are endothermic. This was left unattempted more often than expected.

The main errors in Q20(c)(ii) were omission of the multiple in atomising the chlorine and using the electron affinity. This gave the answer -2750.9 kJ mol^{-1} and could score one of the two marks.
The value +1468.3 kJ mol^{-1} was obtained by adding all the numbers in the table. It was seen frequently but did not score.

Q21

Learners found this surprisingly difficult. The most common error in completing the cycle in Q21(a) was giving incorrect elemental species, usually 2N, 4H and 2O. Also state symbols were frequently missing, or nitrogen was given as a liquid. Missing the 2 for the number of water molecules was another common error.

A significant proportion did not attempt to answer Q21(b)(i), but there were good answers, with clearly set out calculations. Few learners drew diagrams of the molecules to ensure they had accounted for every bond being broken, and they made errors because they did not look back at the structure of N_2H_4 , given at the start of the question. Using only 2 O-H was another common mistake. However many scored the final mark for the principle that the enthalpy change was the difference between the energy released in making bonds and the energy required to break them.

A wide range of answers was seen to Q20(b)(ii). Comments about incomplete reaction, incomplete combustion, or heat loss were not relevant. The mark for the fact that bond enthalpies are average values which vary from compound to compound was scored more often than the mark for bond enthalpies applying to the gaseous state.

Q22

Most learners knew that the initiation step in Q22(a)(i) produced two chlorine radicals, but not all used a curly half arrow in the equation.

The equations given for the propagation steps in Q22(a)(ii) were usually correct, though occasionally they were written for methane.

Most learners wrote one correct termination equation in Q22(a)(iii), though many wrote the equation for formation of chlorine, despite the instructions in the question.

Many learners enjoy finding how to name a complicated structure, but it seemed that some had little experience of skeletal formulae as there were blank spaces in Q22(b). The most common error was to give only two numbers to describe the positions of the three methyl groups on the heptane chain eg 2,4- trimethylheptane. Others interpreted the two methyl groups as an ethyl group.

In the equation in Q22(c)some learners did not balance the oxygens or gave a product other than water.

Those who read Q22(d)(i) carefully, answered it well. However, many did not use the clues given about the products and did not give two different alkenes along with butane. CH_2 and CH_3CH_2 were given frequently as alkenes.

Many learners gained the first mark to Q22(d)(ii) as they knew there was no free rotation about a C=C bond. Some said there was restricted movement but did not refer to rotation, which was not good enough. The explanation of why geometric isomerism occurs is not easy to express. A number of answers referred to different groups being attached to the carbon atoms of the C=C, without making it clear if they were referring to why the isomerism occurs or why it does not. Learners were more successful when they referred specifically to one of the alkenes produced in the cracking process saying, for example, that in ethene the atoms attached to the carbon atoms are all the same, or that in but-1-ene the end carbon has two hydrogen atoms attached.

There were many correct answers to Q22(d)(iii). Structural, displayed and skeletal formulae were all allowed as long as the trans isomer was shown. Not many learners drew skeletal formulae which may be due to lack of familiarity in using them, as suggested in Q22(b).

Q23

Many responses to Q23(a) stopped after saying that a double bond consisted of a sigma and a pi bond, and did not give any detail about the orbitals which overlap to produce the bonds, or the extent of the overlap. Only a few diagrams were seen, but these often showed the required information well. Many learners scored one mark for saying that the pi bond breaks more easily than the sigma bond.

The mechanism in Q23(b)(i) was well known by those who attempted it. Common mistakes were to show a partially charged Br being produced in the first step rather than a bromide ion, and some learners did not draw their curly arrows carefully. The starting and finishing points must both be clear. The reason why 1-bromopropane and 2-bromopropane are not produced in equal amounts was not well known. Many answers referred to one of the products being more stable, without considering the stability of the intermediate. Others referred to the number of hydrogen atoms on each carbon of the intermediate but not to stability.

In the final question, Q23(c), learners lost marks because they just showed the polymer, but did not write the balanced equation for its formation starting with the monomer. Some attempts for the structure of the polymer just showed the repeat unit. This unit should have been shown inside a bracket, with n units outside the bracket, and with extension bonds to neighbouring units.

Summary of advice to learners

- Show your working in calculations, so that intermediate marks can be scored even if you make an error.
- Questions state what you need to do and often contain clues. If you do extra work you will waste time, so read them very carefully!
- Find out the difference between dot and cross diagrams showing bonding, and electron density maps.
- Practice using skeletal formulae for organic compounds.
- In organic mechanisms draw curly arrows carefully. The tail shows where an electron pair is coming from, and the head shows where it is going.
- In organic mechanisms be careful to show whether a species has a full charge or a partial (δ) charge.

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