Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International Advanced Level
In Chemistry (WCH05)
Paper 01 General Principles of Chemistry II
Transitions Metals and Organic Nitrogen
Chemistry

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General comment

This paper contained some questions which were in unusual contexts. Whilst some learners were very well-prepared and were able to score high marks on these, others found them challenging. Many learners were able to demonstrate that they had a sound knowledge of the topics in the specification and were able to apply this to the questions which were of a more standard type with just a few errors or omissions. Those learners who found the paper challenging would benefit from much more preparation to ensure that they know the basic facts, can express their ideas clearly and carry out calculations in both the more usual and more unusual contexts.

Section A

The mean mark for the multiple choice was 10.5. This was quite challenging compared to previous examinations. The highest scoring question was 1(b), where over 80% of learners scored the mark, while two questions, 1(d) and 11(c) were answered correctly by less than 20% of learners.

Section B

Q13

The majority of learners were able to identify the correct half-equation and electrode potential value, though some thought it was necessary to double or half the value. Almost all remembered the positive sign. Most could recognise zinc as the most powerful reducing agent, but the rest of the question proved more challenging. Many thought that the sulfate ion SO_4^{2-} was the species to reduce VO^{2+} to V^{3+}. This reaction would not happen, and it was the other side of this half equation, SO_3^{2-}, which was the correct answer.

Part (c) of this question was a question which is familiar, though in a slightly unusual context. Some learners were able to recognise that V^{2+} was the final oxidation state of vanadium, perhaps simple because they recognised that the mauve colour of the solution indicated this. Fewer, however, were able to successfully write a half-equation for the formation of this final product. This is a skill which is often tested, and would benefit from considerable revision and practice. In (c)(ii) those learners who were able to deduce the source of the colour changes were able to score at least 1 mark, but the recognition of oxygen in the air as the substance causing this change was less common, and consequently the required equations were not common either. Changing colour of transition metal solutions with no obvious second reactant present is often explained by the ease with which some oxidation states can be oxidised by air.

The final part of this question was rather better tackled, with learners recognising a familiar question that they had seen before.

Q14

The diagram of steam distillation was completed very well by a good number of learners, who recognised the need for a condenser. Some made mistakes in their labelling of the direction of water flow, and some used sealed systems with no vent to prevent a build up of pressure as the water vapour is produced for the distillation. The labelling of the two round bottomed flasks was also well done by some learners, but there some who did not recognise how steam distillation worked. A disappointing number of learners did not recognise that the diagram needed t obe completed, despite the bold heading in the question.

Part (b) was answered well, with a good understanding of molecular formulae and of the origins of *E*/*Z* isomerism demonstrated. Part (c) began with the naming of an organic molecule, and though many clearly recognised the molecule required, naming it proved rather more difficult. The mechanism in (c)(ii) is a common question in this examination and was well answered by a number of learners. (c)(iii) is also a question which has been asked a number of times before, with fully correct answers seen often. Care must be taken here to mention that it is the lone pair of electrons on the oxygen atom that are being incorporated into the delocalised electron system of the benzene ring.

Parts (d) and (e) concerned spectroscopic techniques. In (d) it was important to include the postive charge on the ions of the species corresponding to the *m*/*e* values, as it is only the positive ions which are detected. (e)(i) was quite well understood, and this mark was scored often. There were a number of facets to (e)(ii) and it was quite common for learners to miss out one of these and therefore only score 2 of the 3 marks available. It was nice to see some extremely accurate diagrams of the nmr spectrum, which clearly showed that learners had studied these. The relative heights of the parts of the triplet and quartet was not required by the mark scheme, but some learners drew these accurately.

As is often the case, the three step synthesis question in (f) proved to be quite challenging. Most learners obviously read the question here well, as few attempted the possible two step synthesis. Those who answered this question well were clearly often well prepared giving a level of detail in their answers which was above what was required for the marks. There were a number of learners, however, who did not recognise the need for reduction in the first step. Some of these did realise that the alcohol might be a good first intermediate, so were able to score some marks.

Q15

Calculations are usually a strong area in this examination, but this calculation, which is quite an unusual one, proved to be demanding. Learners were able to score well on the first two parts, though some did not multiply by 10 in (a)(i) to take into account the fact that the 10 cm^3 portions came from an original solution of volume 100 cm^3. Part (b) proved most challenging, with only the most adept able to work through this calculation. Some obviously were unsure where to start, while others recognised the need to identify the metal as thallium, but not the need to calculate number of moles of water per mole of compound.

Q16

This question was quite accessible, particularly in the early parts, but some learners are still unsure as to what pH13 means in terms of the concentration of hydrogen ions, with many structures one might be expected as an answer to a question about low pH being seen. The structure of the zwitterion was well known in (b)(ii) but how this was related to the forces between the molecules which gave the high melting temperature was less well understood.

In part (c) there was clearly some understanding of the processes of a chromatography experiment, but the answers were not focussed on the context of the question, and so did not recognise that they amino acids in the hydrolysed mixture needed to be recognised. Ninhydrin as a locating agent was well understood by many, but the use of the spots in identification was less clear. Vague descriptions of measuring R_f value, whist correct in themselves, will not identify the acid unless compared to either a standard spot or to a table of data from a suitable data source. In (iii) it was necessary to be specific about the issue with the use of aspartame in cooking. General use of ‘toxic’, ‘corrosive’ or ‘reactive’ were not sufficient. Many learners, however, knew that peptide links are susceptible to hydrolysis, or would just break down, at elevated temperatures, so scored this mark.

Section C

Q17

The final question had parts accessible to the majority, but also many opportunities for more able learners to express themselves and demonstrate their knowledge and understanding. In the calculation in (a) there were a large number of possible strategies, and most were able to calculate something which could lead them on to the answer. A good number of learners were then able to deduce that the release of gas was a little more than the toxicity limit. 17 (b) concerned iron pentacarbonyl. The shape asked for in (i) was trigonal bipyramidal. This is the standard shape for five pairs of electrons in the valence shell electron pair repulsion theory and should be known to all. This was a novel example, however, and this proved challening for some. Drawings of the structure were disappointing, with no attempt to properly show the shape, and this is an area that would benefit from further work. Showing the shape of structures using coventions of dots and wedges is a skill which requires practice. The dot and cross diagram in (b)(ii) was also unusual as it required learners to use their knowledge of the bonding in transition metal complexes and the interesting example of carbon monoxide. Many learners used the structure which was allowed for 1 of the 2 marks, with a double bond between the C and the O and two lone pairs on the O. This structure does not recognise that the C has only 6 electrons, and that making a triple bond, one of which is dative covalent using electrons from O, would give a more stable structure.

Part (c) again had some opportunities for more able learners. The initial calculation in (i) was found to be tricky, with a full range of marks awarded. Part (ii) was difficult if a good answer had not been found to (i) and so this item scored relatively poorly. A good number of learners who were able to find the formula $Mn_2(CO)_{10}$ were able to suggest an appropriate structure for the final complex.

In (d)(i) the idea of catalysis was commonly suggested, but this was not explained using the equations. The key feature is that the hydrogen ion goes in at the beginning and is regenerated at the end and so is available to repeat. In (ii) there were many correct answers, but there were a great many extra suggestions, such as a negative carbon monoxide molecule at the start, which were clearly incorrect. This novel situation was rather easier than it perhaps appeared. In (d)(iii) a problem specific to sulfuric acid in this industrial context was required rather than general discussions such as ‘it burns’ or ‘it might harm the skin’.

The final item was one in which most were able to score at least one mark, even if only for explaining how a catalyst lowers the activation energy for a reaction. The correct use of adsorption and desorption was gratifyingly common.

Summary of advice to learners

- read the question carefully and make sure that you are answering the question that has been asked
- learn the meanings of all the key terms in the specification
- show all your working for calculations
- practise writing ionic half-equations and check to make sure that equations are balanced in terms of atoms and charges
- practise drawing 3-dimensional shapes using dotted lines and wedges
- practise working out molecular formulae from skeletal formulae of organic compounds
- learn the reagents and conditions for the reactions in the specification.

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