Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

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Pearson Edexcel International Advanced Level In Chemistry (WCH15)
Paper 1: Transition Metals and Organic Nitrogen Chemistry

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Introduction

This is the first examination for WCH15 in the Pearson Edexcel Internation Advanced Level. It follows the same format as the previous WCH05 paper, with Section A consisting of 20 multiple choice questions, Section B consisting of short-open, open-response, caculations and extended writing questions based on familiar and unfamiliar questions and Section C which is a contemporary context question based on a passage of information that the candidates are not expected to have seen before.

Some candidates were very well-prepared for this examination and scored high marks. Many candidates were able to demonstrate that they had a sound knowledge of the topics in the specification and could apply this to the questions with just a few errors or omissions. Other candidates found the paper very challenging and would benefit from much more preparation to ensure that they know the basic facts and can express their ideas clearly.

Section B

Question 21

The majority of candidates scored 2 marks for knowing a suitable solution for use in a salt bridge and that the electrode is made from platinum. Fewer understood that the solution in the right-hand beaker needed to contain both iron(II) and iron(III) ions. Many candidates were unable to write the half-equations for the two half-cells in (b) as they omitted the electrons or deduced an incorrect number of electrons. They should check that equations and half-equations balance in terms of particles and charges. To deduce the overall equation, they need to use the E_{cell} value to work out which direction each half-equation should be, add them together so that the electrons cancel and then reduce the numbers of water molecules and hydrogen ions so they only appear on one side of the equation. This was a challenging question and the majority of candidates would benefit from more practise in writing overall equations from cell diagrams and E_{cell} values . The majority of candidates were able to substitute the correct values into the unfamiliar equation in (c) and calculate the correct value for the electrode potential. Some candidates used an incorrect value for the concentration of chromium ions and others used an incorrect value for the number of electrons in the half-equation. These are careless errors as both values were given in the question.

Question 22

The majority of candidates could identify and correct at least one error in the mechanism. Most spotted that the first curly arrow should start at the ring of delocalised electrons and point towards the NO_2^+ ion and many realised that the second curly arrow should start from the C-H bond instead of from the hydrogen atom. Fewer understood that the 'horseshoe' in the intermediate should have the open end pointing towards the carbon atom with four bonds. Candidates who had learnt the reagents and conditions for the organic reactions in the specification knew the reducing agent for Step 2 in the synthesis of phenylamine and for Step 1 in the synthesis of azo violet. Many candidates scored 2 marks for explaining why phenylamine is a weaker base than ammonia as they knew that the lone pair of electrons on the nitrogen atom would overlap with the delocalised electrons in the benzene ring but many did not complete their answer by relating the strength of base to the ability to accept a hydrogen ion. Many candidates knew that a blue precipitate would form when phenylamine reacts with copper(II) ions. Many candidates deduced the structure of 1,3-dihydroxybenzene that is needed to produce azo violet, although many included extra atoms joined to the benzene ring so were not awarded the mark. A minority of candidates could apply their knowledge of geometric isomerism in alkenes to azo violet and realised that there would also be restricted rotation around the N=N, although there was some confusion with optical isomerism. The vast majority of candidates could draw the optical isomer of phenylalanine.

Question 23

This unfamiliar calculation proved challenging for many candidates. Some candidates did not know the correct formulae for methane and ethane so found it very difficult to achieve any marks. There are many possible methods that are acceptable for this style of calculation and three of these are shown in the mark scheme. Those who started by writing balanced equations for the separate reactions of methane with oxygen and ethane with oxygen were awarded 2 marks as these implied the correct mole ratios. Some candidates tried to write an overall equation for the reaction but this implied a 1 : 1 mol ratio of methane to ethane, which is incorrect. Many candidates found the reaction scheme in (b) to be challenging and didn’t know where to start. Those who looked at the final product and realised that nitriles can be reduced to amines and then that ketones react with hydrogen cyanide and potassium cyanide to form a cyanohydrin, usually scored the majority of the marks, with just an occasional slip. Some candidates tried to introduce a halogen onto the carbon atom with the hydroxyl group, then convert that into a nitrile and reduce could receive up to 4 marks for the last two steps. The first step would not be suitable as it would be impossible to ensure that all of the halogen would substitute onto the correct carbon atom. Many candidates would benefit from more practise in devising reaction schemes.

Question 24

Many candidates found it challenging to complete the equation in (a)(i) as they did not realise that the red-brown precipitate was iron(III) hydroxide. There were many incorrect complex ions shown, with many of them including ammonia ligands. Those who knew a correct formula often failed to balance the equation. A few careless formulae were seen, such as $Fe(OH_3)(H_2O)_3$ and candidates should check their work to avoid this. The vast majority knew that Reaction 2 was ligand exchange or ligand substitution. Candidates who understood that

$NH_2CH_2CH_2NH_2$ is a bidentate ligand usually scored 2 marks in (a)(iii) but there were many who seemed unfamiliar with this ligand. The majority of candidates knew the colours of the vanadium ions in different oxidation states, although some of them could not match them correctly. Some candidates were unfamiliar with these colours. Many candidates worked out the oxidation number of vanadium in the two species in (b)(ii) and as they were the same, they deduced it was not a redox reaction. A few candidates did not state the oxidation numbers and it was disappointing that a few thought that hydrogen or oxygen were being reduced or oxidised. There were some excellent answers to (b)(iii) as candidates wrote the equations for each reaction and calculated the E_{cell} values to confirm whether the reaction would take place or not. Some candidates lost marks by not writing equations and some did not calculate the E_{cell} values, or calculated them incorrectly. Candidates should read the questions carefully to ensure that they have answered all parts. Part (c) is the first extended open response in a Unit 5 and this question was based on the content in Topic 17 points 26 to 32. Some candidates had clearly studied catalysis and gave excellent answers, others had a limited knowledge of this topic and only received credit for knowing about the phases of the different catalysts. The question asked candidates to compare and contrast the two types of catalytic behaviour and many of them did not include the comparison of both types of catalyst providing an alternative route with a lower activation energy. Some candidates confused the catalysts in the Haber process and the Contact Process and some thought that iron(II) ions catalyse the reaction between iodide and thiosulfate ions instead of persulfate ions.

Section C

Question 25

Candidates were not expected to have any previous knowledge of the Lanthanides but they were expected to use the information given in the passage and their knowledge of d-block elements to help them to answer the questions. Some answers showed that candidates did not use the information given in the passage.

The majority of candidates were unable to write the balanced equation in (a). The passage stated that the lanthanide elements are obtained by heating their trifluorides with calcium but many candidates showed the formation of another compound and many were unable to write the formula for calcium fluoride. Candidates should practise writing balanced equations for unfamiliar reactions.

Many candidates seemed unfamiliar with the concept of the stability associated with a half-filled p-sub-shell or d sub-shell so were unable to apply this to the d-sub shell in (b)((i). Some candidates had the right idea but were not awarded the mark as they referred to the stability of a half-filled f orbital. It is important that candidates use correct terminology in their answers. The majority of candidates were able to complete the electronic configuration of Sm^{3+}.

Many candidates worked out that a thulium ion would have more protons than a cerium ion but not all of them realised that this increased nuclear charge would have a greater attraction for the outer electrons. Some candidates just referred to increasing atomic number but this was not sufficient for the first mark. A few candidates incorrectly thought that there would be more shielding in the thulium ion as they were unaware that the number of electrons in the outer shell has no effect on shielding. Many candidates missed the point that the lanthanide ions are larger than transition metal ions so there is space around them to accommodate more ligands.

The passage stated that the colour of the complex ions is caused by f-f transitions but many did not work out that there are no f electrons in La^{3+} ions so there can be no f-f transitions.

The majority of candidates were able to calculate the empirical formula of the cerium compound in (e)(i) but only a minority could deduce the overall formula, using the ion formulae given at the start of the question. A few candidates used the atomic number of cerium instead of the relative atomic mass. There were many correct structures given for the organic compound X, with clear justifications. Some candidates lost marks by not referring to all the evidence and a few contradicted themselves, for example by explaining that it had to be a tertiary alcohol but drawing the structure of a secondary alcohol. Some candidates did not realise that tertiary alcohols cannot be oxidised by acidified potassium dichromate(VI) solution so they thought it was a ketone.

There were many excellent answers to the calculation in (f). Common errors included using an incorrect molar mass for paracetamol and giving the final answer to an incorrect number of significant figures. Some candidates did not use the mole ratio of 1 : 2 and their mass of paracetamol was greater than 0.800 g. To avoid a percentage of greater than 100%, they divided their mass by 0.800 and this was not given any credit. If candidates calculate greater than 100 %, they should go back and check their working.

Summary

In order to improve their performance, students should:

- read the question carefully and make sure that they are answering the question that has been asked
- write concisely and avoid making the same point multiple times
- make sure that comparisons are made when required
- check to make sure that equations and half-equations are balanced in terms of particles and charges
- practise combining half-equations to give an overall equation for a reaction
- be careful with the precision of curly arrows in organic mechanisms
- show all working for calculations and give final answers to an appropriate number of significant figures
- learn the reagents and conditions for the reactions in the specification
- practise answering extended writing questions
- reread questions and answers, where time permits, to avoid careless mistakes.

Grade Boundaries

Grade boundaries for all papers can be found on the website at:
https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

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