Examiners' Report
Principal Examiner Feedback

January 2018

Pearson Edexcel International Advanced Subsidiary Level

Chemistry (WCH05)

Unit 5: General Principles of Chemistry II – Transitions Metals and Organic Nitrogen Chemistry

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General

Some learners were very well-prepared for this examination and scored high marks. Many learners 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. Some learners found the paper very challenging and would benefit from much more preparation to ensure that they know the basic facts, can express their ideas clearly and carry out calculations, showing their working.

Section A

The mean mark for the multiple choice questions was 12.8. The highest scoring questions were 14a, 11a and 11c, with over 80% of learners achieving these marks. The most challenging question was 11b, with 34% of learners achieving this mark.

Section B

Question 12

The majority of learners were able to complete the electronic configurations of Al^{3+} and Fe^{3+} ions in (a)(i), however, some thought that electrons were lost from the 3d orbitals instead of the 4s orbital in the transition metal. Only a small minority of learners could explain the reason why iron forms stable compounds with more than one oxidation number by linking the ionisation energy to lattice and/or hydration energies. Some scored a mark for the idea that there is a gradual increase in ionisation energies. Many just wrote about the stability of a half-full d subshell or just stated that transition metals adopt various oxidation states.

The explanation for transition metal ions being coloured is generally well-known and many learners scored full marks. A small minority lost a mark as they referred to splitting of a d orbital or d shell instead of the d subshell and some referred to light emitted as the electrons fall back to the ground state. Some candidates were confused between the terms degenerate and non-degenerate. These are acceptable terms to use but they must be used correctly.

The majority of leaners were able to draw an acceptable diagram to show the octahedral complex ion in (c)(i), although a small number just drew a flat 'star' shape. Learners should practice drawing 3-dimensional diagrams to represent the basic shapes of molecules and ions in the specification. The majority of learners showed that the oxygen atoms in the water ligands are attached to the iron(III) ion but some ignored that part of the question and showed bonds from the hydrogen or between the oxygen and hydrogen. Some learners were able to score 1 mark for (c)(ii) as they wrote about the solvent water acting as a base. Only a small minority explained that this reaction happens because the Fe^{3+} ion is small and highly charged so polarises OH bonds and a proton is released.

Candidates were expected to use their knowledge of the bonding in Al_2Cl_6 to answer (d). Some learners did realise that a dative covalent bond could form between aluminium and a chloride ion but they did not explain that this can happen because the aluminium has an empty orbital.

The majority of learners could give the type of reaction taking place in (e)(i) but only a small minority could draw a correct dot-and-cross diagram for the thiocyanate ion and work out which atom has the negative charge. Some learners decided to mix up the order of atoms in the ion and showed sulfur or nitrogen in the centre of the ion and many showed diagrams with unpaired electrons. Many learners omitted the instruction to show the structure of the ions, showing all of the bonds. Only a few learners used their dot-and-cross diagram to suggest that both sulfur and nitrogen have a lone pair so either of them could form a dative covalent bond in the complex ion.

Learners were expected to use their knowledge of the reactions of chromium(III) hydroxide with acid and alkali to write the equations for the reactions of aluminium hydroxide with acid and alkali. Some learners did not read the instruction to use ionic equations, however, they could score 1 mark for two correct equations using HCl and NaOH. Learners should check their work to avoid careless errors in formulae, such as $Al(OH_3)$.

Question 13

There were many acceptable methods for calculating the molecular formula of T in (a)(i) and many learners scored full marks. Some learners did not use all of the information given in the question and received a lower mark. Learners should be encouraged to explain their working so that if they do not get the correct final answer, they can be awarded some marks if the examiner can understand how they have worked it out. Many learners could give two correct species in (ii), however, some omitted the positive charges and a few added a continuation bond. Many learners could use the proton nmr data to deduce the structure of compound T but not all of them explained how their structure is consistent with the data. Learners should be encouraged to circle and label the different proton environments on the displayed formula.

It was pleasing to see that many candidates were able to work out the three step synthesis of 2-hydroxy-2-phenylpropanoic acid in (b)(i). Some learners omitted the Friedel-Crafts catalyst in the first step but many learners did score full marks. Some learners tried to start from propanoyl chloride but this would not join onto benzene with the correct carbon atom so they could go no further. A few learners tried to use an acyl chloride with an –OH group also attached but again this would join in the wrong position. Some learners tried to draw mechanisms, but this was unnecessary in this question. The structure of the polymer in (ii) was generally well-answered, although some learners lost a mark when they showed parts of three repeat units instead of two complete repeat units and some showed O-O peroxy linkages rather than esters.

Question 14

Some learners could write the overall half-equation for the oxidation of vanadium(II) ions to vanadium(V) ions in (a)(i) but a significant number of learners did not balance the equation using H^+ and H_2O and many did not attempt to balance the charges. The majority of learners worked out that Fe^{2+} ions would reduce vanadium(V) to vanadium(IV) but not to vanadium(III) and they explained their reasoning clearly, although some made errors in calculating E_{cell} values. Some learners realised that they needed to use the Fe^{2+}/Fe^{3+} half-equation but showed confusion as they stated that Fe^{3+} or iron was the reducing agent. Some learners chose unsuitable reducing agents but could score 1 mark if they could explain how that species could reduce vanadium(V) to vanadium(IV). Some learners could write the equation for the disproportionation of vanadium(III) ions and explain why the reaction was not feasible. Again, some learners did not balance the equation in terms of atoms and charges.

The calculation in (b)(i) was done well by the majority of learners, with just a few losing a mark for not using the mole ratio. Some learners carried out the more demanding back-titration calculation in (ii) very well and got as far as the mole ratio but then were unable to write the balanced equation. This was a difficult equation and the learners could have used the mole ratio and the change in oxidation numbers to deduce that thiosulfate ions would be oxidised to sulfate(VI) ions.

Question 15

Many learners would benefit from more practice at working out a molecular formula from a skeletal formula. The majority of learners could label the chiral carbon atom in pinocembrin although some labelled more than one carbon and some labelled a carbon in the benzene ring.

The quality of drawing reaction mechanisms has been improving but there are still some learners who do not seem to understand the meaning of a curly arrow and some cannot draw the correct intermediate, especially in a substituted benzene.

There were many incorrect intermediates drawn in (c)(i). Some had the correct diazonium functional group but showed the positive charge on the wrong nitrogen atom but there were many incorrect functional groups. The majority of learners correctly suggested ammonia as the reagent in (ii), although methylamine was a common incorrect answer. Many learners worked out that methanol is produced in (iii). Some learners used the information given in (iv) to deduce the structure of the sodium salt of saccharin but many did not realise that the nitrogen would have a negative charge when the H^+ ion is lost.

Some learners were able to deduce the correct organic compounds in (d), although an acyl chloride was often seen in (i) and some learners moved the position of the NH_2 group in (iii). A few learners showed covalent bonds between ions e.g. $O^-{-}Na^+$ in (ii).

Some of the learners realised that a reducing agent was needed to convert glucose into sorbitol in (e)(i) and the majority gave lithium tetrahydridoaluminate(III). A few learners must have mis-read the question and gave an oxidising agent. The tests to identify an aldehyde were often well-known and all the alternatives in the mark scheme were seen on scripts. Common incorrect tests included the use of sodium carbonate, phosphorus(V) chloride and acidified dichromate(VI) ions. A minority of laerners lost marks by giving incorrect or incomplete observations e.g. a red solution formed with Fehling's solution instead of a red precipitate. Only a small minority of learners were unable to complete the formula of sorbitan.

In order to improve their performance, candidates should:

- 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 equations for the reactions of amphoteric hydroxides with acid and alkali
- check to make sure that equations are balanced in terms of atoms and charges
- practise combining half-equations to give an overall equation for a reaction
- practise drawing 3-dimensional shapes using dotted lines and wedges
- practise working out molecular formulae from skeletal formulae of organic compounds
- be careful how you draw curly arrows and intermediates in organic mechanisms
- learn the reagents and conditions for the reactions in the specification.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx