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Examiners' Report/
Principal Examiner Feedback

Summer 2014

Pearson Edexcel GCE
Chemistry Unit 6CH05 Paper 01R
General Principles of Chemistry II

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General:

This examination was similar in style and standard to previous and parallel Unit 5 papers of this specification. A range of skills and knowledge was assessed and the levels of difficulty allowed good discrimination between the different grades, while allowing well-prepared candidates at all levels to demonstrate their abilities. There were no dead marks but 21biii was correctly answered by only 13.8% of candidates, reflecting the difficulties evident elsewhere in the paper with ionic equations, compounded here because relatively few candidates could identify the chromate(VI) ion. It was evident that, even at this level, candidates do not take sufficient care in reading questions and context material before framing their responses.

Section A (Multiple Choice)

The multiple choice questions were accessible to all candidates and it was easily the highest scoring section of the paper with a mean score of 73.7%. Five questions were answered correctly by more than 80% of the candidates; these were, in order of increasing difficulty, 1, 4, 13, 12 and 19. The hardest question was 18, which was still answered correctly by over 56% of candidates.

Section B

20a

A number of candidates wrote half equations for the reduction of oxygen in alkaline rather than acid conditions or equations involving the oxide ion, which, of course, does not exist in aqueous solution. Even with the correct half equations, care was needed to correctly balance the equation; a number of candidates wrote equations with electrons. Candidates need to be encouraged to use the Data Booklet in answering this type of question.

20bi

Despite its central position in the specification, this equation still caused some problems with a few candidates who were unfamiliar with the manganate(VII) reduction product. Again, some candidates attempted to balance their equation with electrons.

20bii

In addition to candidates who gave the end-point for the reverse titration, there was a surprisingly wide range of colours suggested, the most popular being ‘reddish-brown’.

20biii

There were many excellent answers to this calculation with the working clearly set out and explained. Common errors were omission of a scaling factor and failure to convert the percentage remaining into the percentage oxidised, despite the improbability of the final value.

20biv

It was evident that the use of significant figures is poorly understood by many candidates with some offering no explanation at all and others unable to link their choice with the data in the question. A few candidates confused significant figures with decimal places.

20c

Few candidates made use of the simple equilibrium ideas required by the first part of this question and simply asserted that it occurred in acid conditions. Writing the disproportionation equation proved a challenging exercise for a number of candidates and there were some attempts to side-step the need to work with the ferrate(VI) ion by using an equation involving Fe^{6+}, despite the wording of the question. Candidates who had successfully navigated the first two parts of this question usually had few difficulties in calculating the feasibility of the disproportionation.

21a

Lack of precision in this definition was the most reason for the loss of the mark, often suggesting that transition metals, rather than their ions, have partially filled d orbitals.

21bi-ii

The identification of the chromium species and of the reagents in the sequence proved highly discriminating. Only the better candidates were able to identify the chromate(VI) ion and a suitable reducing agent. Candidates need to be aware that the instruction ‘identify by name or formula’ requires a specific substance. A number of candidates gave ‘primary or secondary alcohol’ for reagent B and gained no credit despite evidently understanding the chemistry involved.

20biii

Even the candidates who knew the chromate(VI) ion found completing this equation a challenge, there were frequent failures to balance the charges, keep the solution alkaline and provide an ionic equation.

20biv

While most candidates could write the equation for this reaction, many assigned the incorrect oxidation number to the nitrogen in ammonia (often suggesting +3 or −4) and the explanation of the redox nature of this reaction often omitted to specify which species were oxidised and reduced.

20bv

The oxidation of chromium(II) was usually well explained.

20ci

While there were many precise definitions of ligand, candidates often omitted one or other of the required features. Candidates should try to match their response to the mark allocation.

20cii

Not all candidates realised that the ligand in the complex would be the ammine, suggesting instead that a hydroxo complex would be formed. There were difficulties even when the ligand was correctly identified with the complex carrying no charge or a negative charge.

22ai

While most candidates correctly identified the electrophile for nitration, there were quite a number of incorrect equations.

22aii

Despite its familiarity, the descriptions of the mechanism of electrophilic substitution were extremely varied in their quality, reflecting, in part at least, the understanding of the steps being described. Errors of detail were common, especially affecting the structure of the intermediate. In particular the precise chemical significance of the Wheland horseshoe and the importance of its orientation and the position of the positive charge seemed not well understood.

22aiii

Most candidates understood why phenol is more reactive than benzene, with the best giving precise accounts of the interaction of the oxygen lone pair with the π electrons of the ring.

22aiv

While the low yield of 4-nitrophenol was generally well understood, the question inevitably attracted some careless answers referring to the use of sodium nitrate as well as stock responses about transfer losses and even the number of steps in the process.

22av

Despite the specific requirement for a reagent suitable for an aqueous solution, the most common response was lithium tetrahydridoaluminate(III).

22avi

Most candidates were able to complete this calculation successfully.

22bi-ii

As a rule candidates are familiar with the steps involved in recrystallization but this question did show that candidates do not fully understand how the procedure works.

20biii

Most candidates gained this mark.

22c

The item on mass spectrometry was well answered with few candidates opting for the tallest peak as the molecular ion. Most were able to suggest a sensible structure for m/e = 43, with just a few losing a mark by omitting the charge on the ion.

22d

The element of common sense required in this question was not always to the fore, with candidates suggesting that paracetamol packs carry labels describing the hazards associated with the drug and that sellers should wear mask and goggles.

Section C

23ai

The comparison of the intermolecular forces of ethoxyethane and ethanol was well rehearsed by most candidates. The description of the intermolecular forces of ethoxyethane was the most likely source of error, with some candidates stating that the compound would have no permanent dipole-dipole interaction while others thought that these forces would be stronger in this case than the London forces.

23aii

Candidates frequently relied on the usual environmental and industrial generalisations such as the effect on the ozone layer, atom economy and cost rather than focusing on the specific question. However, in all the discussion, most candidates managed at least one mark.

23aiii

Candidates were more likely to score a mark for understanding that the stability of desflurane would result in it remaining in the atmosphere for a long time, than for appreciating the importance of the strong C–F bond on its stability. Despite the information in the stem of 23aii, a number of candidates brought the ozone layer into their discussion, suggesting that fluorine atoms would affect the ozone in a similar way to chlorine atoms.

23b

The effects governing the basicity of procaine were well understood and described, sometimes with impressive detail, by many candidates. Some candidates omitted to mention the nitrogen lone pair and there were occasional references to the electron withdrawing effect of the benzene ring. This last description is not normal usage of the term and gives rise to issues when describing the effect of such an electronegative element.

23ci

Most candidates failed to realise that the equilibrium established would be a drawback of the proposed esterification, instead relying on generalisations about cost and hazardous reagents. Candidates who scored the mark were more likely to refer to the reversibility of the reaction, perhaps not fully appreciating the distinction between the two terms.

23cii

Even when candidates identified the formation of the acid chloride as a suitable intermediate for the alternative synthesis, the reagents were often incorrect as was the structure of the acid chloride. The acid catalysed esterification was a surprisingly frequent choice although it was ruled out in the stem.

23di

Many candidates showed a poor understanding of nmr spectra and responses were rather polarised with few candidates scoring one or two marks.

23dii

Precise explanation of the advantage of HPLC over nmr proved the main problem with some quite long answers touching on the key points but failing to make them fully.

Advice to candidates

1. Read the questions and passages fully and ensure that your answers meet the requirements of the question and match the mark allocation.

2. Learn the ideas behind organic mechanisms and do not rely on just memorising the sequences.

3. Make sure that you understand the use of significant figures and the difference between significant figures and decimal places.

4. Set out your calculations in a logical sequence and try to show what you are doing at each stage. Do not round intermediate values in your calculation and make sure that your final value is sensible.

5. Make sure that you are familiar with the Data Booklet and remember that it can be useful for questions other than those for which it is specifically required.

Grade Boundaries

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