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Examiners' Report
Principal Examiner Feedback

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General Comment

There was evidence of some very well-prepared candidates giving a clear demonstration of their chemical knowledge and understanding, in a practical context. However, there was also a significant number of candidates that gave responses which revealed a poor understanding or awareness of the experimental procedures and techniques expected at this level. Candidates would certainly benefit from more experience at these and their exam performance will inevitably improve from doing so.

Question 1

Part (a) was a familiar-style question on the tests of aqueous solution of transition metal ions was generally answered well, with the majority of candidates awarded marks. It appeared that some candidates misread cobalt for copper and so gave incorrect observations and inferences. An example of this was in (a)(v) where the complex ion was sometimes seen given with four ammonia ligands as per copper(II) instead of the six which cobalt(II) complex ion has. Hence a useful reminder to re-read the question to ensure the right element is being considered. A common incorrect answer given in part (a)(iv) was "ligand exchange" but the reaction is an example of deprotonation.

Many of the responses seen for part (b) were rather disappointing given that this was an AS experiment, albeit with a transition metal compound. It had been expected that this would be a high scoring question but this proved not to be the case. This was the first question in the paper which possibly reflected the lack of practical experience by the candidates. Despite the introduction clearly stating that the cobalt salt was a solid, it was not unusual to see responses which described the heating under distillation of the salt as if it was a solution. Indeed some responses referred to a volume of the salt being measured. It was also common to see responses which referred to the heating of the salt in a conical flask or beaker, neither of which is appropriate. The higher scoring responses clearly referred to or described the idea of 'heating to constant mass' but some candidates simply stated to "heat until all the water was evaporated" but gave no indication as to how this would be discerned. It was worth noting that the change in colour of the salt is insufficient to confirm that all the water has been removed.

Question 2

The majority of candidates understood the need for filtration in part (a) but then did not go on to score the second mark which was to rinse the filtered sand of any residue of sodium hydroxide. This is a useful illustration of how the number of marks allocated to the question can help in guiding candidates into how many points to make in their answer. It is 'best practice' when filtering to always rinse the filtrate and so it is possible that the lack of this point in candidates reponses was a reflection of a lack of practising filtration in the laboratory.

Part (b) was a higher-scoring question than part (a), although a significant number of candidates described the making up of a 250.0 cm^3 solution in a beaker or conical flask instead of a volumetric flask. It is worth reminding candidates that an important part of the process is to invert or to mix the contents of the flask to ensure a homogenous solution.

The calculation in part (c) proved to be an effective discriminator as it gave marks across the spectrum. It was clear that many candidates are very competent at this type of activity and even only needed a few lines of working to get the correct percentage. The task was accessible and even those less proficient were able to gain credit for what they could do.

As highlighted earlier, the number of marks is a useful indicator of the depth required in an answer. In part (d)(i) there were three marks available and the first was for the remaining ammonia reacting with the acid, which then led to the second mark for the result on the titre of an increase, which subsequently meant that the calcuated percentage in the fertiliser woul be less. This kind of methodical or logical approach would benefit many candidates. It was not unusual to see a response which simply stated that the titre would increase without any justiification. Although the titre does increase, the mark was not awarded without some reason being given.

Some of the responses to part (d)(ii) were 'classic examples' of where the candidate did not gain the mark because of the lack of stating what might seem to be 'obvious'. One illustration of this is a response which states that "the litmus paper would change not colour if ammonia was present". The omission of the original colour of the litmus paper means that this mark cannot be awarded. It might seem 'obvious' that "red" litmus paper would be used but since there is a choice between blue and red litmus paper, it has to be clearly stated by the candidate which is bieng used. A minority of candidates described the use of a stopper of a concentrated HCl bottle being held near the vapour which was fine as long as "white smoke" and not 'white fumes' were given as the observation if ammonia was present.

Question 3

In part (a) the vast majority of candidates were able to correctly show that butanoic acid was in excess in the procedure. A small minority used the values given in all manner of different ways which did not gain any credit.

Part (b) had one mark for the equation and one mark for the justification. There were a number of different ways that the equation between the acid and the sodium hydrogencarbonate could be given, especially since there were two acids present. It was a pleasure to see many excellent equations. The justification for the opening of the tap or the removal of the separating funnel needed to refer to the pressure from the gas being produced. It is worth noting that some, otherwise creditworthy answers, were spoiled by reference to an explosion or that the funnel would break.

The question in part (c) was a novel test of a candidates real experience with the use of a separating funnel. The diagram clearly showed that the

stopper was still present in the top of the separating funnel and it is true life experience with this technique which teaches us what happens or does not happen when this is the case. The reduced pressure in the funnel either means that no lower aqueous layer will leave through the tap or if some does then air will enter through the tap and inevitably mix up the two layers. It was pleasing to see a number of responses where the candidates had a very good understanding of this situation but these were relatively rare. It is possible that some candidates were aware of the issue described but simply did not spot the presence of the stopper in the diagram. If this is the case then it is a sobering reminder to carefully consider the diagram before responding.

The use of drying agents in part (d) were generally answered well. The best answer of the organic liquid going clear was seen a number of times but alternatives such as the drying agent remaining as a powder, rather than clumping together, were also allowed. These responses did suggest that candidates has more experience of the use of drying agents.

The two proton NMR questions in part (e) were another example where candidates were often hindered by the lack of precision in their answers. In part (i) the splitting pattern mark was only awarded if there was reference made to the adjacent "carbon" having two protons. Frequently this was missing. In addition it was insufficient to simply quote the (n+1) rule.

Additional errors included the labelling of the carbons in both ethyl butanoate and in ethyl propanoate as being responsible for the proton NMR peaks. This was clearly evident when the carbonly carbon of the ester bond being circled as being responsible for a set of peaks. The sextet was often incorrectly stated to be a quintet.

Question 4

The lack of understanding of the procedure for this kinetics investigation was seen in some of the suggestions for the apparatus to use in removing a sample from the reaction mixture as required in part (a). Examples to illustrate this lack include burette, measuring cylinder and even forceps.

The mark for part (b)(i) was very rarely awarded. As previoulsy highlighted the lack of precision again seen in candidates answered proved their undoing. It was not enough to just state that the change in volume was proportional to concentration. It was important to state which substance the concentration was referring to. This demand was shown to be correct because responses were seen which incorrectly stated that the change in volume was proportional to the concentration of alcohol rather than the ester.

Candidates generally appreciated that part (b)(ii) required reference to half life. The question clearly stated "Show your working on the graph" and so it was disappointing when this was missing. Some candidates spoilt their answers by stating that the half lives were constant but then quoting 0.7 hours for the first half life and 1.4 hours for the second half life.

Occasionally candidates misquoted the units and so is another reminder to carefully check the answer before moving on.

As in previous examinations there are often times when the candidate needs to retrieve and use information from earlier in the question or in the rubric. This was the case with part (b)(iii). Despite the emboldening of water being in "a very large excess", many candidates failed to reference this fact and instead tried to use the constant half lives as evidence for the reaction being first order overall. Hence this is another reminder for candidates to appreciate the significance of how the information is presented in a question.

It was evident that some candidates were well-prepared for the determination of reaction rate from a graph whilst others were clearly not. The first mark awarded was for the drawing of a tangent at 2 hours. A small minority of candidates drew tangents but not at 2 hours and so did not gain credit. It is worth reminding candidates that it is best to make the tangent line as long as possible since this reduces the error. The second and third marks were for the calculation of the rate from the tangent and so the absence of a tangent lost these marks, unless the data points were used when one of the two marks was awarded. It seemed that a significant number of candidate thought that the units of rate had to be mol dm^{-3} s^{-1} and so carried out rather convaluted calculations to try and convert cm^3 h^{-1}. Hence centres need to help their candidates appreciate that a range of different units can be appropriate. The fourth mark was for the units and so this proved to be an effective discriminator.

The more able candidates generally understood that the final question, part (c), was referring to quenching and gained one mark. The second mark was much less awarded. Information in the rubric of the question stated that samples were taken only every 30 minutes and so the best answer was that it would make no difference to the validity because the reaction was already very slow. However almost no one picked up on this point and so an alternative argument was allowed that the hydrolysis of the ester needed to be slowed so that the acid concentration would not change during the titration. This enabled a small minority of candidates to score this second mark. A common misunderstanding seen from the less able was that the ice cube would melt and decrease the concentration which would supposedly alter the titre value.

Summary

To improve their performance, candidates should:

- read and then re-read the question to make sure that they are answering the question being asked
- check the mark allocation of the question to ensure that the depth of their answer and the number of points being made in their answer matches the question demand
- practice as much experimental technique as possible and if not able to do so personally then to see others doing so because a visual demonstration is much more easily remembered plus also paying particular attention to why various steps are carried out
- make sure that working is always shown, especially when specifically requested in the question and this includes working on graphs
- consider carefully the question rubric because there are 'clues' or hint which will help with answering later questions and note any parts which are emboldened

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