Examiners' Report

Summer 2013

GCE Chemistry (6CH04) Paper 01R
General Principles of Chemistry I

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General

The June 2013 paper, the first in the Time zone (01R) series, was of a similar standard to previous 6CH04/01 papers, testing similar skills using questions which were mostly of a standard type, some very straightforward others more demanding.

The mean score in the multiple choice section was 70.9%, significantly higher than in section B (62.3%) but similar to that in section C (68.9%). Over 90% of candidates gave the correct response to (in order of decreasing difficulty) the following multiple choice questions: 3c, 5b, 4a.

The multiple choice questions that proved the most challenging were: (correctly answered by 15.8%), 8 (30.8%), 3d (39.7%) and 10 (46.7%). There was no formal experimental plan on this paper, but items requiring knowledge and understanding of practical work were embedded in the questions.

The paper discriminated effectively between candidates at the various levels and offered a range of scoring opportunities for the reasonably well-prepared candidates. The Quality of Written Communication was tested very effectively both in those questions that required some extended transactional writing and in the calculation questions; in both situations the more successful candidates focused on relevant material and set out their answers clearly and concisely.

During calculations many candidates carried values from previous stages in their calculator so answers did not always correlate to stated values; many candidates seemingly disregarded instructions about the inclusion of signs, units and significant figures. While some candidates seemed to rush parts of question 13, the majority of candidates were able to complete the paper within the allotted time.

Question 11

This question covered a number of aspects of thermodynamics and equilibrium. Most candidates were able to access many of the marks, largely due to transferred error marking through the calculation, but many failed to adequately cope with the higher level explanations and this led to a good level of discrimination.

In part (a) many candidates seemed unaware of the colours for iron(II) and iron(III) and those that knew the colours were often unable to correctly describe the change, suggesting that they had not actually seen any such experiment. 'Silver mirror' was a common error, indicating confusion with an aldehyde test.

In part (b) a surprisingly small number of candidates were able to correctly calculate the simple dilution in (b)(i); most could then calculate the moles of Ag+, but the subsequent conversion of amount into concentration proved

more demanding. The 1:1 ratio of Ag^+ to Fe^{2+} was generally clear, but many then continued this ratio to the RHS to calculate the same number of moles of Fe^{3+} in (iv). The main problems in (v) were the inclusion of [Ag(s)] in the K_c expression and a misunderstanding of significant figures.

In part (c) most candidates could use the equation correctly to calculate ΔS_{total} and most correctly identified the formation of a solid, but a much smaller number clearly explained this as the reason for the negative value. The calculations in (iii) and (iv) were quite straightforward and the explanations of the effect of temperature on ΔS_{total} were often very clear.

In part (d) the QWC question was very difficult for all but the top quartile of candidates. Most assumed that removal of the Ag(s) would force the equilibrium to the right, possibly corresponding to a misunderstanding in (v).

Question12

This question combined aspects of unit 4 organic chemistry with acid-base equilibrium. Many candidates were able to access a large number of the marks but the QWC questions were again very discriminating.

In part (a) most candidates could explain why old stocks of aldehydes react with sodium carbonate in (i) but then stated that they would not react in part (ii). In (iii) a significant number of candidates could not give the correct formula of sodium carbonate. Part (iv) revealed a problem with reading information from the data book: some gave a value of 3300 cm^{-1} as originating from a COOH group whilst some suggested that it was from an alkyl group on an acid. Very few correctly named a hydrogen bond as the reason for broadness. Failure to use the correct terminology was a specific problem encountered in part (v): many candidates talked about 'splitting' which could be clearly interpreted as number of lines within a signal, but others gave a number of 'splits' which technically refers to the number of gaps between lines. Others gave answers which combined terminology and gave a very confused answer overall.

In part (b) the sketch of the titration curve was generally poorly executed. Most started the line around pH = 3 and many realised that there was a vertical section at 25 cm^3, but this vertical section was often too long and not vertical. The most common error was to have the final pH above 13, the value for the pure NaOH solution.

In part (c) there were very few problems in (i), but some candidates could not correctly name an acyl chloride in (ii).

In part (d)(i) the common error was to omit the '1' from the name of butan-1-ol. Most candidates have learned the correct solvent for $LiAlH_4$ and most

could identify the reaction type, but a much smaller number could give a valid and connected justification.

Parts (e)(i) – (iii) were largely straightforward and most candidates could find suitable advantages from the allowed list where they had given a valid answer to (iii) ; some omitted the hazard caused by HCl and failed to score the disadvantage mark. Weaker candidates used generic advantages and disadvantages, failing to appreciate the importance of linking these to the specific example.

Question 13

This was, in many respects, a typical question on rates of reaction, linking into an unfamiliar mechanism in which candidates were expected to apply their knowledge of mechanism and its relationship with reaction kinetics. This clearly confused many candidates and was another good discriminator.

In part (a) most candidates could convert the volume into mass and then into a number of moles and then further into a volume. Far fewer could give 2 valid reasons why this volume was likely – many gave a list of reasons, rather than stopping at 2; many suggested that the gas would be condensed back into the flask or that it would be lost through ill-fitting joints and leaking tubes.

In part (b) a majority of candidates were unable to clearly explain the importance of a large excess – most merely stated that if would make all the but-1-ene react or that it would not be a limiting reagent. The graph was generally well drawn, with axes clearly labelled, although only a very small number were able to connect the volume with the concentration of bromoalkane. The understanding of half-lives was very variable with a significant number measuring the second half-life as the time from zero to the actual time rather than from the end of the first half-life – hence the values would be 2.5 mins and 5 mins. They then went on to say that this showed a first order reaction as the half-lives were the same.

In part (c) most candidates were much more secure when calculating rate order from tabular data and then writing a rate equation, but this did not always correspond to the value in (b)(v). Rate constant units were generally correct. In part (iv), the drawing of the arrows was generally very poor and inaccurate; they were frequently shown going from atom to atom rather than bond to bond. The arrow to Br was more successful, but this was sometimes shown moving well past the Br atom. The explanation often failed due to lack of specific mention of RDS or slow step.

Hints for revision

- Improve knowledge of chemical formulae.

- Clarify terminology in NMR spectroscopy: use of singlet, triplet etc.

- Recall that solids do not feature in equilibrium constant expressions.

- Improve precision when sketching pH curves

- Avoid the use of 'human error' or 'faulty equipment' as reasons for errors in experiments.

- Clarify ideas about measurement of half-lives.

Understand that mechanistic arrows must clearly show the initial and final positions of electron pairs.