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Examiner Report / Principal Examiner Feedback

January 2014

IAL Chemistry WCH01/01

Unit 1: Core Principles of Chemistry

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January 2014
Publications Code IA037622

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General

This paper had many straightforward questions that all candidates could access, but It was also sufficiently challenging for the most able students who were given an opportunity to show the extent of their knowledge and understanding of the unit. A number of scripts with a raw mark of 70 or more out of 80 were seen. Several questions produced responses lacking precision, with words such as ion and atom being used interchangeably.

Question 17

Parts (a)(i) and (a)(ii) provided a straightforward start to Q17. Part (b)(i), however, proved to be far more challenging. Although many candidates were able to identify the structures of both silicon and phosphorus, there was often confusion as to the nature of the interactions overcome on melting. A significant number of candidates stated that covalent bonds between phosphorus atoms were broken on melting, rather than London forces between molecules. Rather too often, incorrect references were made to 'molecules of silicon' and 'ions of phosphorus'. In (b)(ii), the Quality of Written Communication was thoroughly tested. Many candidates confused the process of melting with that of ionization, with answers referring to the removal of electrons from a magnesium atom frequently being seen.

Candidates' consideration of the metallic bonding in magnesium and sodium often overlooked the difference in ionic radii of the magnesium ion compared with that of the sodium ion. The electrostatic attractions between cations and delocalised electrons, present in metallic bonds, were often confused with those between the nucleus and outermost electrons in an isolated atom. In (c), many candidates recognised the idea of electrons occupying the same outermost shell moving across the period, resulting in the same degree of shielding by inner shells of electrons. However, a sizeable number of candidates thought that the atomic radius was decreasing because of the increasing number of electrons rather than protons.

The dot-and-cross diagram in (d) was correctly drawn by the vast majority of candidates. Part (e) proved to be discriminating, with a significant numbers of candidates' graphs in (e)(i) showing the first ionization energy steadily increasing. The drop from magnesium to aluminium was often not recalled.

In (e)(ii), numerous answers simply stated the electronic configurations of aluminium and silicon. There was often some discussion of the structures of these elements, which suggested that candidates did not appreciate the fact that first ionization energy measurements related to gaseous atoms.

Question 18

Writing the ionic equation in part (a)(i) provided a challenge for many candidates as solid barium carbonate is insoluble in water and so the barium ion cannot be deleted as a 'spectator ion' in this instance. The majority of candidates could state two observations that would be made on the addition of barium carbonate to dilute hydrochloric acid. In (b), many of the answers to the calculations were very well set out and, therefore, easy to follow. Part (b)(i) was generally answered correctly. In (b)(ii) and (b)(v), the common error was to omit the 2:1 ratio. Other common incorrect answers to (b)(v) were those in the 'Reject' column of the Mark Scheme. In (b)(iv), there was some confusion between how to remove the excess barium carbonate and crystallization to obtain the final product. 'Fractional distillation' was often suggested as a suitable technique, revealing a widespread lack of practical awareness.

In Q18(c)(i), many candidates were able to name the energy changes accurately. In (c)(ii), however, the energy change box was left blank on a number of scripts, possibly due to the requirement of the question being overlooked. Some candidates referred to 'ionization' instead of 'electron affinity'. Others thought that the value of −697.6 kJ mol^{-1} arose from the addition of the first plus second electron affinities of chlorine, rather than simply doubling the first electron affinity. Part (c)(iii) proved straightforward for candidates who set out their working appropriately. In (c)(iv), some candidates failed to recognise the significance of comparing the experimental and theoretical values, thinking instead that it was a comment on the success of an experiment. For those candidates who recognised that the bonding was 100% ionic, or very close to it, few of them were able to access the second mark which required a precise comment relating to the lack of polarization of the anion by the cation.

Question 19

Part (a) required an application of the concept of parts per million and this proved troublesome to about half of the candidates.

In (b)(i), most of the candidates were able to write the balanced equation for the complete combustion of methanol. However, incorrect state symbols were sometimes included. In (c)(i) to (iii), the majority of candidates were able to carry out the calculation correctly. The negative sign was not always included, however, and the requirement for the final answer to be given to three significant figures was also overlooked. In (c)(iv), a minority of candidates were able to access the first mark, recognising that methanol is volatile, but very few were able to explain the effect of this factor on the magnitude of the experimental value. Whilst candidates often stated that the enthalpy change of combustion determined would be less exothermic than the true value, they did not relate this to the actual mass of methanol burned being less or the estimated mass of methanol being burned too high. In (d), some candidates recognised that bond enthalpies are average values, thereby accessing the first mark. The second mark was more difficult to gain, with candidates referring solely to 'non-standard conditions', without mentioning specifically that bond enthalpies refer to all species in the gaseous state.

Question 20

Part (a) was answered well. Part (b)(i) proved more challenging, with some confusion over the naming of *E*/*Z*−isomers apparent. The structure of the diol in (b)(iii) was correctly identified by just under half the candidates. In (b)(iv), for the most part, candidates understood the concept of larger molecules breaking into smaller molecules. Only a few confused the process of cracking with the fractional distillation of crude oil, or reforming of straight-chain molecules. In (b)(v), several candidates did not read the question carefully and wrote an equation for the cracking of but-2-ene, C_4H_8, instead of octane, C_8H_{18}, but the majority of candidates wrote the correct equation. In (c), the type of addition was correctly identified as electrophilic. The name of the product was frequently correct, although some named it as 2, 3- instead of 1, 2-dibromopropane. A minority of candidates forgot to include the 'di' in 1, 2-dibromopropane. The quality of the 'curly arrow' mechanism was variable.

There were several instances where the arrow went from the bromine molecule to the double bond. Sometimes, half-headed arrows were used. The free radical substitution mechanism was in some cases confused with that for electrophilic addition. The initial two curly arrows in the mechanism often originated from atoms rather than from the relevant covalent bonds.

Even if the curly arrows were incorrect in the first step, many candidates were able to access the mark for drawing a correct carbocation intermediate.

Most candidates remembered the negative charge on the bromide ion, but a number then forgot to draw the arrow from the bromide ion to the carbocation. Part (d)(iii) proved very demanding. The vast majority of candidates misunderstood the term 'sustainability', thinking instead that it referred to longevity. Many who clearly understood the meaning, however, failed to state that the polymer's use was 'not sustainable', as required by the Mark Scheme.

Hints for revision

- Learn your definitions thoroughly, such as **unsaturated hydrocarbon**
- Try to practise as many of the different types of calculation question found in this unit
- Try to practise the naming of alkanes and alkenes
- Make your writing clear. If the examiner cannot decide whether you have written "s" or "g" when a correct state symbol is required, you will not get the mark
- Make sure that your answer is directed to the question set. If you know several facts about a situation, you must restrict your response to those which answer the question.

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