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Examiners' Report January 2009

GCE

GCE Chemistry (8CH01)

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6CH01/01

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 significant number of scripts with a raw mark of 70 or more were seen. Several questions produced responses lacking precision, with words such as ion and atom being used interchangeably.

Question 19

In (a) (i) and (a) (ii), many candidates were able to give the correct electronic configurations, although 1p and 2d sub-shells were occasionally seen. In (b) (i), the formulae of the species were often correctly given, but there was some confusion over which state symbols to use. In (b) (ii), the majority of candidates knew that the bonding in magnesium chloride was ionic. Part (b) (iii) proved to be more challenging, with a significant number of answers showing the bonding in magnesium chloride as covalent rather than ionic. Candidates who did not read the question carefully drew only the outer shell electrons on the magnesium and chloride ions, instead of all the electrons in each species.

Quality of Written Communication was thoroughly tested in (d). 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. Answers which attempted to consider 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.

Question 20

Part (a) provided candidates who had thoroughly learnt and understood the principles of the mass spectrometer with an opportunity to score high marks. In (b), the correct method for calculating the relative atomic mass of chromium was frequently seen, but the final answer was not always given to three significant figures as was required by the question. In (c), the fact that the four isotopes had the same electronic configuration needed to be made. A sizeable proportion of candidates stated that all four isotopes had the same number of electrons in the outermost shell, or other similar responses, which seemed to be answering a different question (e.g. explaining the similarity in chemical properties of elements in the same group of the Periodic Table).

Question 21

Part (a) elicited many wholly correct, or partially correct, responses. In (b), an equation to show the process occurring when the first ionization energy of sodium is measured, instead of the second ionization energy, was often given. Furthermore, in several scripts the chemical symbol for sodium was shown incorrectly but one mark was awarded for an otherwise correct answer. Part (c) (i) proved very straightforward for those candidates who knew the trend in first ionization energy across Period 3. Many excellent answers were seen to (c) (ii). These responses clearly described the increase in the number of protons in the atoms of the elements from Group 1 to Group 0, the fact that the outer electrons were in the same shell and the resulting increase in the force of attraction between the nucleus and the outer electrons of the atoms of the elements concerned. In (c) (iii), many answers focused on the $3s^2$ electrons in the magnesium atom rather than the 3p electron being lost from the aluminium atom. Part (d) was well answered and the chance to apply chemical logic in an unfamiliar context was welcomed by many.

Question 22

In (a), a significant number of candidates did not fully discuss the definition of a covalent bond and simply referred to “sharing electrons.” In (b), despite the structure of nitrous oxide being drawn out on Page 17 of the question booklet, many candidates seemed unfamiliar with how to represent both the dative covalent bond and the triple bond.

Question 23

In (a) (i), many candidates were unsure as to what to use for the “mass of solution” in the expression given, but they were able to score consequential marks in (a) (iii) and, subsequently, (b) (ii). In (a) (iii), a sizeable number of candidates thought that the reaction described should have a negative enthalpy change value as the temperature change had been given as -4.9 °C in the stem of the question. Some of those candidates who realised that the reaction was endothermic then went on to omit the positive sign, despite being asked to include a sign in their answer. In (b) (i), relatively few candidates realised that $\Delta H^{\ominus}_1 = \mathbf{2 \times} \Delta H^{\ominus}_2 - \Delta H^{\ominus}_3$ and it was evident that further practice of this type of Hess’s Law calculation would have been of benefit to many candidates. In (c) (i), those who understood the concept of percentage error were able to score one or both of the marks available and many excellent answers to (c) (ii) were seen.

Question 24

In (a), a sizeable majority of candidates were able to state the general formula of an alkane. In (b) (i), cracking was frequently stated as the correct response, but in (b) (ii) the process of reforming was less well known. Answers to (c) and (d) (i) showed a sound knowledge of skeletal formulae, but the branched isomer (compound 2) proved difficult for many to name correctly. In (e) (i), the signs for the two enthalpy changes were often reversed as candidates had used a “products – reactants” formula instead of adding the mean bond enthalpies for the bonds broken (positive sign) to the mean bond enthalpies for the bonds made (negative sign). Consequential marking then allowed credit to be earned for a logically correct answer to (e) (ii). Part (f) was found to be straightforward by those with a clear understanding of the concept of parts per million (ppm).

Hints for revision

- Learn your definitions thoroughly, such as **first ionization energy**.
- 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.

6CH02/01

General

The small number of entries made it more difficult than usual to spot reliable trends in performance. However there was evidence of a number of general themes occurring in the work of candidates. For instance questions set in a practical context proved challenging for many, both in terms of knowledge and understanding of practical skills and recall of likely observations. Calculations linked to experiments however were handled competently, but with little appreciation of the limitations of the numerical data. Concepts with significant overlap with previous specifications, for instance collision theory, showed candidates could give succinct and generally accurate answers within a familiar chemical context. However some of the new content posed more problems. For instance the notion of a skeletal formula, despite the example in the paper being relatively simple, seemed beyond many candidates.

Question 18

Knowledge of reagents and conditions required for the reactions in (a) was variable. Whilst some candidates were able to recall most information with only minor errors or omissions, many did not provide sufficient detail or gave contradictory answers. For instance whilst the importance of an aqueous solvent in (a) (i) was often suggested, the presence of the ethanolic solvent in (a) (iii) was less prevalent. A minority of candidates failed to score credit for recall of a suitable hydroxide in (a) (i) or (iii) because they suggested additional use of an acid catalyst.

In (b) a number of good responses clearly recognised the ability of sulfuric acid to behave as an oxidizing agent and then could often apply this idea to justify the subsequent reaction with iodide ions. However too many generalised responses were seen, with ideas that it 'would be too reactive' or 'concentrated acid is dangerous' commonplace. A number tried to justify their idea that the reaction would be too reactive with reference to the reactivity of the elemental halogens but were unable to successful link this back to any likely reaction of iodide ions. Use of the terms 'iodine' and 'iodide' continue to be interchangeable for some candidates.

Candidates found naming the halogenoalkane in (c) (i) straightforward though occasionally spurious **incorrect** use of numbers lost credit. However the skeletal formulae in (c) (ii) posed a surprising number of problems. Many answers gave a displayed formula and of those who did attempt a skeletal formula, many did not realise the need to show a bond to the fluorine atoms. In (c) (iii) most successful responses occurred when students didn't attempt to overcomplicate their answers. Hence the smothering effect and removal of heat could both score credit. Whilst more complex answers related to the free radical mechanism of combustion could have scored, a number of candidates tried to suggest the halogenoalkane reacted directly with the oxygen, without realising that they were suggesting it would behave as a fuel. In (c) (iv) the role of CFCs in ozone depletion was widely known and a number of good responses were seen with equations to justify both the formation of chlorine free radicals and subsequent reaction with ozone. Fewer candidates made an attempt to justify the continued use of CF_3CHF_2 and those that did tended to argue that it was somehow less stable so would break down quickly after use. A minority of answers seemed to believe both compounds would break down to release the free halogen but fluorine was less hazardous than chlorine of bromine.

Question 19

Part (a) was well answered by most candidates, who recognised the reduction of Cu^{2+} and justified it in terms of change in oxidation number. It was surprising to see a large number of responses choosing an acid-base indicator in (b) (i) with methyl orange the most common incorrect suggestion. Calculations in b (ii) and (iii) were handled competently. However justifications of the use of three significant figures in the final answer for (iii) lacked precise detail. Many simply said 'because the other concentration is to 3SF' without any consideration that this was least accurate level of measurement used in the experiment. In a similar vein, in (b) (iv) most answers gave the stock response 'you can't repeat results' with little indication as to how this inhibits the ability to spot anomalies or assess repeatability.

Question 20

The shape, name and angle in part (a) posed few problems though a small number suggested the shape was pyramidal. Whilst many could determine the HNH angle in ammonia few could justify the difference in angle when compared to boron trifluoride. Many answers discussed the problem as though both molecules had similar electron arrangements around the central atom but ammonia's lone pair would repel more than the bond pairs, reducing the angle by a small amount. Very few appreciated the idea that ammonia simply had four electron pairs surrounding the central atom, compared with boron trifluoride's three, hence it would have a smaller angle in order to maximise electron pair separation.

Most candidates managed to score some credit in (b) (iii) and (iv). However a minority thought ammonia had permanent dipole – permanent dipole interactions rather than specifically naming hydrogen bonds.

Understanding of the effect of temperature and catalysts on rate in (c) was sound. Better candidates were able to describe, with reference to their graph, how the number of particles with $E > E_A$ changed at the lower temperature and correctly predicted an appropriate change in shape of the curve. A number of weaker responses in (b) (iii) didn't link the fall in E_A to an alternative mechanism or intermediate and simply suggested that this would result in 'more collisions' rather than the idea that a greater proportion of the total collisions would result in a reaction. As this question was highlighted as being assessed for the quality of written communication, the former did not gain credit.

Question 21

The unfamiliar half equation in (a) discriminated quite effectively at the higher levels. Those candidates who could correctly balance the half equation in (a) (i) often went on to score some credit in (a) (ii). Responses to (b) suggested that candidates need to ensure they have a better understanding of key experimental techniques. In (b) (i) the better answers tended to describe a specific outcome e.g. 'it will get too hot and boil over', whereas weaker responses were generic, such as 'it will be reactive' or 'it will be dangerous'. Diagrams in (b) (ii) often showed inappropriate equipment, ranging from heating in an open beaker to distillation apparatus. Even when recognisable as heating under reflux, errors such as sealed apparatus, poorly drawn joints and incorrect water flow were common.

Many candidates could correctly predict the effect of pressure on yield in (d) (i), often with a sound justification. Some responses to (d) (ii) had clearly considered the implications of scaling up the lab reaction and could suggest issues such as poor potential yield, toxicity of $Cr_2O_7^{2-}$ or the undesirability of a batch process. Weaker answers tended to either describe problems that already apply to industrial processes, e.g. ‘the process would have a number of stages’ or seemed to be attempting to scale down the industrial processes, hence suggesting that high temperatures and pressure would be difficult to achieve in a laboratory.

The best responses in (e) interpreted several of the pieces of information from the stem of the question and used these to construct a clear comparison of the two processes. Clear use of language ensured statements demonstrated this comparison, rather than relying on implication. Often answers covered both angles of a marking point, further emphasising the ability of a candidate to evaluate. For instance, when talking about the raw materials, responses that not only discussed the potential use of sustainable wood as a source of methanol, but also the use of crude oil as a source of butane with a judgement to support why one may be preferable to the other were observed. Further supporting information was requested that enhanced the ability to make a judgement rather than suggesting information that was already available in the question or facts that would not really contribute to the evaluation. For instance, catalysts were discussed in terms of their cost and effectiveness, rather than just suggesting it would be helpful to know the name of the catalyst in the second process.

Less successful responses tended to use some information from the question, for example, recognition of the difference in pressure. However when a degree of processing of the information was required e.g. consideration of atom economy, credit was less likely to be awarded. Answers at this level often suffered from a lack of clarity, perhaps leaving the examiner unclear as to which process was being discussed. Often candidates made individual statements about one process without an obvious comparison, either directly or by implication, to the alternative.

Hints for revision

- Chemistry is a practical subject so pay careful attention to make sure you recall and understand key practical skills such as heating under reflux and distillation, as well as recalling the observations from your experiments.

- Ensure that you are able to evaluate any experiments or data you use to make a considered judgement on their accuracy or reliability.

- Build up a ‘chemical database’ of reagents and conditions for key reactions. Learn and practise recalling them so you can quickly and effectively answer questions that simply need you to remember them, leaving you more time in the exam for more challenging questions.

- Try to ensure you make comparisons in your answers explicit. Use phrases like ‘higher than...’ or ‘greater than...’ rather than ‘high’ or ‘great’ to make sure an examiner can see you are comparing two situations.

Appendix A: Statistics

6CH01/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	80	53	46	40	34	28
Uniform boundary mark	120	96	84	72	60	48

6CH02/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	80	56	50	44	39	34
Uniform boundary mark	120	96	84	72	60	48

Maximum Mark (Raw): the mark corresponding to the sum total of the marks shown on the mark scheme.
Boundary Mark: the minimum mark required by a candidate to qualify for a given grade

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