

# Examiners' Report January 2007

GCE

## GCE O LEVEL CHEMISTRY (7081)

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## 7081/01

### Question 1

Most candidates scored highly but the formula of the nitrate ion was often written with a double negative charge.

### Question 2

Some candidates ignored the instruction to give names and were subsequently penalised. It was surprising to find 'oxygen' written as the answer to (a). The lowest scoring part was (e), despite the fact that the oxidation state of copper was not insisted upon; the reference to a 'blue solid' triggered a response of 'copper sulphate' in many cases.

### Question 3

Aspects of rusting are well known to most candidates so high marks were common. In (b), vague statements such as 'coating with another metal' were not rewarded. Some answers to (c) were spoiled by references to magnesium 'rusting'.

### Question 4

Although this question was generally well answered, the double negative charge was often missing from the sulphide ion and the number of electrons ascribed to the potassium ion was frequently given as '19'.

### Question 5

The first three parts caused relatively few problems but (d) and (e) were poorly answered by even the good candidates. 'Sodium sulphate' in (d) and 'chlorine' in (e) were common incorrect answers.

### Question 6

The tests for the gases were well known but there were few correct reactants given. Candidates should note that if they choose to test for ammonia using fumes from hydrochloric acid then 'concentrated' must be specified; 'HCl' is too vague for either the acid or the gas.

### Question 7

This question posed problems for many candidates as few realised that the answers to (a) and (b) can be obtained simply by looking at the mole ratio as given in the equation. Only the best candidates could perform the calculation in (c); often, it was not seriously attempted.

### Question 8

The ability to write formulae and balance equations is fairly well developed in most candidates; common errors were 'NaCO<sub>3</sub>', 'NH<sub>4</sub>' and '2N'.

### Question 9

Most candidates can draw good graphs but there were instances of mis-plotted points, particularly the last one. The graph was a straight line through all the points and a ruler should have been used to draw the line. Part (b) was usually correct but in (c) some answers stopped half-way. Few correct responses were seen to (d) because it was not realised that it is necessary to double the mass before reading a value from the graph. In (e), the instruction to 'use the data in the table' was sometimes ignored and figures from the graph were used.

### Question 10

Generally, this question was well done. Common errors were to forget the carbon-carbon bond in C<sub>2</sub>H<sub>5</sub>Br in (b) and to give the number of atoms in only one mole of CO(NH<sub>2</sub>)<sub>2</sub> in (e).

### Question 11

The definition of 'hydrocarbon' was spoiled by the omission of 'only' and by reference to 'an element' rather than 'a compound' in the statement 'a compound that contains hydrogen and carbon only'. In (ii), a positive statement was required for the definition of 'saturated' and not 'it does not contain double bonds' or similar. Although many correct structures were written, the instruction to circle one carbon atom and draw an arrow to the other was often ignored and two circles were drawn; this automatically scored no marks. Good candidates were comfortable with (c) but weaker ones failed to appreciate the significance of the references to moles.

### Question 12

This question demanded factual knowledge about extraction of metals and many high scores were seen. Common errors were to suggest hydrogen rather than carbon monoxide in (a), to use magnesium or iron in (b) and to fail to state that aluminium ions **gain** electrons in (c).

### Question 13

In order to score highly in (a), it was necessary to realise that the yellow precipitate was silver iodide; those who thought it was silver bromide were allowed consequential credit for B, however. The process in part (b) was well known and many correct answers were seen.

#### Question 14

This question proved to be testing for many candidates. In (b), the excess of copper(II) sulphate was to ensure that **all the metal** reacted and not simply 'to have a complete reaction'. Very few realised that at a high temperature copper would oxidise (most said it would melt). The calculation proved to be difficult for many but it was a simple manipulation of moles - particularly as it was a 1:1 ratio.

There were numerous guesses at the identity of the metal in (d)(ii) and (iii) but marks were not awarded if there was no valid calculation in (i). In (e), there were surprisingly few correct colours given for the deposited metal and it was relatively rare to see a statement that copper ions are responsible for the blue colour. The main problem in (f) was a lack of precision; many knew that M would lose electrons but did not state that it is oxidation and there were numerous statements that 'copper gains electrons' whereas it should be made clear that copper ions gain electrons.

## Introduction

The paper appeared to be well received with very few part questions left blank, suggesting that, most of the time, candidates had some notion of what was required, even if responses were not always correct. There were many instances where I felt that candidates had undersold themselves by failing either to include sufficient detail in their answers or failing to express their knowledge in a way which would bring them the maximum reward available. Specific examples of this are given in the question analysis.

My overall impression of the quality of answers on the paper is that there are many students taking this examination who have an extremely good grasp of the subject content and who are ideally prepared to continue their studies in chemistry at a higher level.

As is always the case, the paper covers a wide range of syllabus content and provides opportunities for candidates to display their knowledge and understanding of chemistry together with other skills such as the application of knowledge in an unfamiliar context.

All of the section B questions appeared to attract similar numbers of candidates and it was not apparent that any one of them was significantly more popular than another.

### Question 1

Candidates tended to do particularly well on this question, if they knew their chemistry, or if not, particularly badly, relying more on guesswork than knowledge. Easy marks were lost on silly errors like failing to give the oxidation state of iron in iron(III) hydroxide and copper(II) oxide, or not balancing the equations correctly. Some candidates omitted essential detail when describing the reaction of aqueous ammonia and aqueous copper(II) sulphate. They either failed to state that the first product was a precipitate and/or that the second product, the complex ion, was a deeper blue solution. In each part, the question asked for the product that contains the transition metal ion so candidates were penalised if other products were included in their answers.

### Question 2

Knowledge of the electron arrangements and shapes of both ammonia and carbon dioxide were extremely well known and a high proportion of candidates achieved all of the marks available for this part of the question. Candidates needed to identify the correct particle responsible for position in the Periodic Table and the existence of isotopes. Responses in terms of atomic number and mass number were not acceptable. Most candidates were able to go some way in describing how the electron configuration of elements relates to their position in the Periodic Table but a significant proportion failed to give a satisfactory generalised statement in addition to the specific example required.



### Question 3

The formation of an ester provides another example where answers were often lacking important detail. The catalyst for this is **concentrated sulphuric acid** and must be identified as such. Heat was sufficient to obtain the second mark but if a temperature was given it had to be within a sensible range. There was clearly some confusion between this process and industrial processes. Many candidates lost marks for not identifying both of the compounds that would react with aqueous sodium carbonate and both of the compounds that would react with bromine water however subsequent accounts of reaction details were often very good. In order to obtain the final mark candidates needed to show the formula of the product in such a way as to indicate that a molecule of bromine was added across the carbon-carbon double bond.

### Question 4

Accounts of the reaction of bromine water with sodium chloride solution and sodium iodide solution were often very comprehensive and accurate in all details. The most frequently encountered error was the mention of purple solutions and/or purple vapour in connection with the displacement of iodine. A significant number of candidates lost an easy mark by failing to balance the equation for the reaction between sodium iodide and bromine water. The order of reactivity of the halogens was very well known. Most candidates knew the positive tests for chlorides and iodides using aqueous silver nitrate. There was very little confusion between the colours of the precipitates and that formed in the same test by bromides.

### Question 5

The significance of the different numbers of moles of reactants and products in respect of an increase in pressure was not well known although many candidates were able to identify increasing cost as a problem associated with operating processes at high pressures. Incorrect answers relating to increasing the pressure were often about colliding particles and the effect on the rate of the reaction rather than the equilibrium position. The vast majority of candidates were able to identify the reaction as exothermic but far less were able to relate this to the low operating temperature needed to maximise the yield and the subsequent effect this would have on the rate of reaction. A high proportion of candidates identified the mixture of zinc oxide and chromium oxide as a catalyst and commented on the effect this would have on the rate of reaction. The commonest error was to suggest these compounds acted as drying agents for the gases. The final calculation was generally well done, as were all of the calculations on the paper.

## Question 6

Accounts of the preparation of crystals of sodium nitrate and copper(II) sulphate were generally good but failing to provide sufficient detail often lost candidates some of the marks available. In the former preparation it was necessary to ensure the final solution was both neutral and free from indicator. To do this, once the neutral solution was made the indicator needed to be removed using activated charcoal or alternatively, the preparation could be repeated without an indicator using predetermined quantities of sodium hydroxide and nitric acid. In the latter preparation it was necessary to use an excess of copper(II) oxide to ensure all of the sulphuric acid had reacted, and then to remove this excess by filtration. In both preparations, crystals are obtained by heating to remove some of the water and allowing the remaining liquor to cool. It is not good practice to heat the salt solution to dryness.

The preparation of iron(III) chloride was less well known but there were still many good answers. Candidates were least familiar with the knowledge that this substance sublimes and a suitable collection vessel is required. Among the incorrect answers, the commonest mistake was to suggest that the compound could be made by the reaction of iron and hydrochloric acid.

The calculation to find the percentage of magnesium in kieserite was often totally correct and candidates attained the maximum marks available. Similarly, the test for a sulphate was very well known and described. A small number of candidates suggested acidifying with sulphuric acid which would, of course, invalidate the test.

### Question 7

Most candidates were able to provide some details of the reaction of sodium and potassium with water but although answers were often factually correct they did not provide descriptions of what takes place. The question asks candidates to identify three similarities and one difference but answers were too often organised in a way which did not bring out these points thus marks were lost. Relatively few candidates appeared aware of the fact that the hydrogen formed in the reaction with sodium generally does not ignite during the reaction whilst that formed in the reaction with potassium always does.

The electronic configuration of sodium and potassium were almost universally known and there were many excellent accounts relating the increasing reactivity down the group to increasing number of shells and diminishing effective nuclear charge.

About half of candidates were able to apply their knowledge of the chemistry of Group 1 compounds to correctly predicting the effects of heat on rubidium carbonate and rubidium nitrate. The remainder thought that both of these compounds decomposed in the same way as analogous Group 2 and transition metal compounds.

Knowledge of the electrolysis of aqueous sodium chloride was very variable. Some candidates were clearly very familiar with this whilst others became confused about the products at each of the electrodes. Some common errors were: stating that chlorine left litmus colourless rather than bleaching it; suggesting that litmus turns blue at the cathode because sodium is an alkali metal and identifying chlorine as an important compound produced industrially.

The flame test used to identify sodium and potassium compounds was very well known and described.

### Question 8

The process of fractional distillation was very well known and most candidates scored well for their descriptions however, separation on the basis of different boiling point was frequently not stated with sufficient clarity to obtain full marks. Similarly, the process of cracking is equally well known however answers were often insufficiently detailed. Candidates were vague about the starting material and what was formed from it. The reasons given for why it is used were often too vague to be worthy of credit. The formation of ethanol from ethene was reasonably well known however, the reaction conditions were given were not always complete or correct. The modern process uses a phosphoric acid catalyst and does not involve an intermediate formed by reacting ethene with sulphuric acid. The later reaction has not been used in industry for some time and should not be taught to students. Most candidates were able to identify the polymerisation process as addition polymerisation but relatively few gave the correct polymer unit. Most frequently, a formula for the polymer itself was given. The calculations to find the empirical formula and molecular formula of the unknown compound were often faultless, again reflecting the high standard of calculations throughout the paper.

## Question 9

Overall, the responses to all parts of this question were relevant but lacking in sufficient detail. The structures of both diamond and graphite were generally well known and often drawn but this was not enough for the marks available. There needed to be some description of the strong covalent bonds and tetrahedral structure of diamond, and the layered structure of graphite in which only weak bonding exists between layers. Too frequently, candidates talked about weak bonding in graphite as if the bonds between the carbon atoms in each layer were weak. Many candidates described graphite in terms of its ability to conduct electricity when this was not relevant to the question and received no credit.

Accounts of sodium frequently identified free or moving electrons rather than delocalised electrons. There was often some confusion over the ability of ionic compounds to conduct an electric current. Common errors were to state that the ions did not exist when the compound was a solid and that the ionic compound conducted electricity when molten or in solution due to mobile electrons. Very little comment was made about the passage of electricity in terms of carrying current or charge.

Most candidates were aware that magnesium oxide is an ionic compound but many failed to mention the strong attraction between **oppositely** charged ions. Similarly, most candidates were aware that water was a covalent compound but rather than describe the weak forces of attraction between molecules, they talked about weak covalent bonds as if the bonds between atoms needed to be broken for water to become a vapour.

Almost all candidates were aware that argon is a noble gas with a full outer octet but relatively few went on to say that there was therefore no need for argon to gain, lose or share electrons thus its lack of reactivity. Only a small proportion of candidates appeared aware that the atoms in a nitrogen molecule are held together by a triple bond which requires a large amount of energy to break. Responses were often in terms of nitrogen having 5 electrons in its outer shell and needing to lose 5 or gain 3 for a full outer octet.

Almost all candidates knew about isomers as compounds with the same molecular formula but different structural formulae but far fewer thought to draw the two isomers of the compound given.

## Appendix A - Statistics

Grade	A	B	C	D	E
Boundary mark	72	56	41	36	23

### Notes:

**Boundary Mark:** the minimum mark required by a candidate to qualify for a given grade.

Grade boundaries may vary from year to year and from subject to subject, depending on the demands of the question papers.

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