

Examiners' Report January 2008

GCE

GCE O Level Chemistry (7081)

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7081/01

General

The paper provided candidates with an opportunity to demonstrate their knowledge and understanding of a wide range of topics and many high marks were achieved. Calculations were well performed but explanations of molecular behaviour were often lacking in clarity and precision. Candidates should note that correct oxidation states are important when naming compounds such as potassium dichromate(VI) and when a candidate elects to give both a name and a formula in response to a question, both must be correct in order for a mark to be awarded.

Question 1

Most candidates were able to write these formulae correctly, the most frequent mistakes occurring with the formula for ammonium sulphate.

Question 2

The first two rows were usually correct but, in the third row, the mass number was often quoted as '80'.

Question 3

Candidates found parts of this question quite difficult. Few recognised sodium sulphite in (b), 'sodium' was a common response in (c) as was 'ethane' in (e). Part (d) asked for 'gases' so 'hydrochloric acid' was not accepted.

Question 4

Questions requesting colours of substances usually cause problems but this was fairly well answered, the main errors being to describe copper(II) carbonate as 'blue' and to give the colour of methyl orange in alkaline solution as 'red'.

Question 5

The answers to this question were variable in quality with no easily discernible pattern of errors; the correct answer to (e) was rarely seen.

Question 6

Most candidates scored well on this question, the main error being to write 'neon' in response to (b).

Question 7

The most common mark here was 4. The main errors were to state that 'atoms' are fixed in position and that 'ions' carry the current to the negative electrode rather than the more precise 'cations'.

Question 8

Parts (a) and (b) should have been easy marks to obtain as an introduction to the remainder of the question and this was generally the case. To score further marks, it was necessary to precisely identify the species being oxidised and to give a reason appropriate to that species. In (i), 'K₂SO₃ gains oxygen' was expected but if a candidate decided to use increase in oxidation number, then it had to be specified that it is the sulphur that increases its oxidation state (from +4 to +6). In (iii), it is the Sn²⁺ (and not just 'Sn') that is oxidised by loss of electrons. In (d), equations were often not balanced correctly. Candidates did not always state that calcium carbonate is involved in the reactions that eventually produce calcium silicate or slag; they implied that calcium oxide was the starting point.

Question 9

The responses to this question were very variable. The question asked for lines to be drawn to represent covalent bonds and stated clearly that electron arrangements were not required; this was frequently ignored. There were numerous simple diagrams drawn that showed the bonding and shape of each of the molecules adequately without the necessity of an attempted three-dimensional effect. Some genuine attempts to show the shape were spoiled by joining the hydrogen atoms with solid lines (representing covalent bonds); more successful diagrams used dotted lines to emphasise the shape (but this was not necessary in order to obtain full marks). The diagram for carbon dioxide often had single bonds and/or was V-shaped.

Question 10

The calculation in (a)(i) was usually correct; in (a)(ii), it was necessary to demonstrate that the relative formula mass of CH₂Cl is half that of the isomers and hence the formula needs to be doubled. The two displayed formulae were rarely correct as many candidates simply moved the chlorine atoms to a different orientation on the original carbon atoms and thus repeated the structure; others tried to draw a structure for CH₂Cl. In (b), the repeating unit was often not clearly drawn to show the relative locations of the hydrogen atoms and the methyl group. A representation such as (-CH₃CH-CH₂-)_n is not precise enough to gain full marks.

Question 11

The explanations caused problems as candidates did not express themselves clearly and unambiguously. In (a)(i), the answer 'high' had to be accompanied by a correct reason in order to score marks; an answer that referred to increase in rate of reaction was rejected. A minority of candidates recognised that there was no change in the number of moles and so an increase in pressure would not affect the position of equilibrium. Although many candidates thought that an increase in pressure would increase the rate, they did not state that the particles would be forced closer together thus increasing the frequency of the collisions; most were content to say that there would be 'more collisions'. The remainder of the question was well answered.

Question 12

Part (a)(i) was quite well answered but in (ii) compound D was often stated to be sodium sulphate; compounds E and F were usually correctly identified although throughout this question oxidation states were sometimes incorrectly assigned.

In (b)(i), the common error was to omit the addition of a named strong alkali and to simply state that the ammonium salt would turn red litmus blue; this gained no marks. If the evolved ammonia is tested for by use of hydrochloric acid fumes then it is essential that **concentrated** acid is specified; the dilute acid will not work. Litmus paper is an acceptable and simple test as ammonia is the only common alkaline gas.

In (b)(ii), the use of silver nitrate and dilute nitric acid was expected and this was the most common answer. Candidates who suggest the use of silver nitrate and hydrochloric acid do not understand the chemistry of this analytical procedure.

Question 13

There were numerous perfect answers to this question but many candidates got confused by the numbers of the various bonds. In (a)(i), many correctly calculated 4030 kJ but then proceeded to add on the two Br-Br bonds. Part (iii) was often correct despite errors made in (i). In (iv), a common error was to use 4×350 giving an answer of 4960 kJ. In (v), it was necessary to write the figures in the correct order i.e. bonds broken minus bonds formed which is $+4420 - 4619 = -190 \text{ kJ mol}^{-1}$. Arithmetical errors were not penalised more than once as the transferred error principle was applied throughout the question. In (b), a colour **change** was asked for so 'bromine is decolourised' did not gain the mark.

7081/02

All questions were accessible to all candidates with every marking point on the paper being scored, and there was a wide range of marks. As in previous examinations, examiners found that the standard of calculation work was very good; however it was disappointing to see a lack of application of practical work and many candidates could not balance simple equations.

In Section B, Q9 and 7 were the most popular, although candidates struggled to score marks on Q9(a). Q8 was the least popular. Candidates should realise that the number of lines given for each part of the questions is sufficient for a complete answer and long descriptions are unnecessary.

Section A

Question 1

This question was concerned with laboratory, (not the industrial) preparation of gases. Most candidates knew the combination of reagents used in (a) and (b), but only the better candidates realised that chlorine was prepared by the oxidation of concentrated hydrochloric acid. Failure to describe sulphuric acid as concentrated and calcium chloride as anhydrous lost marks for the drying agent in (a) and (c), but most candidates knew that a basic drying agent, quicklime, is used to dry an alkaline gas in (b). Gases were collected over water on a number of scripts despite the question demanding the collection of the dry gas. There is still confusion over the use of the term displacement of air; downward delivery is synonymous with the upward displacement of air.

Question 2

In (a), an ionic bond is the attraction between oppositely charged ions. Descriptions of the formation of an ionic bond by the transfer of electrons, given by most candidates, were not rewarded. A covalent bond is the attraction between a bond pair of electrons and the nuclei of the atoms. The answer required reference to a shared pair of electrons for the first mark.

Part (b) was generally well answered. Most candidates knew that the Na^+ and Cl^- ions occupied alternate positions on the diagram. The three shared electron pairs generally scored the first mark in (ii), but the second mark was frequently lost by failure to include the three lone pairs around each chlorine and/or the lone pair on nitrogen.

The explanation of the low boiling point of covalent compounds in (c), continues to provide problems for candidates. Answers must make reference to the fact that covalent compounds exist as molecules, and that only a small amount of energy is required to overcome weak intermolecular forces and so separate the molecules. Covalent bonds within the molecule are strong and are not broken.

Question 3

In (a), most candidates knew that oxygen is obtained industrially by fractional distillation, but failed to realise that liquid air is used.

Part (b) was very poorly answered. It was not appreciated that metals above and below hydrogen in the reactivity series could be separated by dissolving the more reactive metal, magnesium, in sulphuric acid and by recovering the less reactive copper by filtration.

Part (c) tested the interpretation of the given data. Niger red and Sudan yellow were the answers to (i) and (ii). Despite being told what measurements to make in order to calculate the R_f value, candidates had difficulty in reading the chromatogram. Any value between 3.0 and 3.5 was allowed for the distance travelled by the dye, which was divided by 6.0 for the solvent front measurement. Many candidates did not appreciate that the chromatogram produced from a drop in the centre of a piece of filter paper would result in circles with the yellow dye being on the outside.

Question 4

In (a)(i), the answer expected was that a long-chain hydrocarbon contains many carbon atoms. There were many incorrect answers in terms of polymer structures. All organic compounds contain carbon and hydrogen but hydrocarbons are compounds of carbon and hydrogen **only**. Cracking was recognised as the process in (a)(ii), but the conditions of high temperature (not just heat) and/or the presence of a catalyst were not well known. Reference to an unsuitable catalyst negated the catalyst mark. The equation in (a)(iii) was generally well answered, but weaker candidates could not write the formulae of both ethene and propene.

In (b), candidates should be aware of the conditions used in the industrial manufacture of ethanol from ethene; a value between 50 to 100 atmospheres was required for the pressure, and the acid catalyst is phosphoric acid and not sulphuric acid. There were surprisingly many incorrect equations in (ii). A positive statement about this process was required for the answer to (iii); the method being faster or continuous. Credit was not given for a negative response to the fermentation process.

Question 5

In (a), the end-point is taken when the indicator shows a pink colour. The precautions required were specific to the detection of an accurate end-point and not to a titration as a whole. Examiners were looking for the drop-wise addition of the alkali near to the end-point and the constant swirling of the flask during the addition or the use of a white tile to help with the detection of the colour change.

Only a few candidates had difficulty with the calculation in (b), which required the use of the relationships, $\text{moles} = (\text{titre in cm}^3 \times \text{concentration}) / 1000$ in (i) and $\text{moles} = \text{mass} / \text{relative molecular mass}$ in (iii).

The idea of repeat titrations in (c), to find the average of two concordant titrations was well understood.

Section B

Question 6

Most candidates in (a), knew that a catalyst altered the rate of a chemical reaction, but far too many gave the incorrect statement that a catalyst does not take part in the reaction instead of the required answer that a catalyst remains unchanged at the end of the reaction. The test for oxygen was well known.

The diagram in (b), required a sealed container and a method of collection which enabled the volume of the gas to be measured, e.g., a gas syringe. Examiners withheld the first mark if students heated the contents of the flask. The graphs were generally well plotted and drawn and often scored full marks. Candidates do not, however, understand that the time when a reaction is half complete, is given by the time when half of the total volume of gas has been formed.

In (d), candidates must appreciate that if they have to sketch, on the same axes, graphs to show the progress of the reaction under changed conditions, they must consider two factors; a comparison of the rate and the final volume of the gas formed.

In (c), candidates were expected to use the decrease of the gradient with time in (i) and increase of the gradient at higher concentrations in (ii) to support their answers. Both kinetic theory explanations were based on change in concentration; in (i) as the concentration decreased, there were less particles and hence less **frequent** collisions whereas in (ii) an increase in concentration led to an increase in particles and hence more **frequent** collisions.

Many candidates scored full marks on the calculation in (e).

Question 7

Part (a) generally proved to be a high scoring question. Marks were lost through the use of oxygen rather than air when burning sulphur and also in the oxidation of the sulphur dioxide, and by writing equations that were not balanced correctly. The conditions for the oxidation of the sulphur dioxide were well known.

In (b), the ions and the electrode equations were well known, but it was not appreciated that by gaining electrons the hydrogen ions are reduced at the cathode and that by losing electrons the hydroxide ions are oxidised at the anode.

Very few candidates realised in (c)(i), that an **excess** of zinc oxide is added to **hot** dilute sulphuric acid followed by filtration to remove the excess oxide and thus failed to score the three available marks. Reduction of the volume of water followed by cooling was required for the crystallisation mark. The equation was well known.

A number of different approaches could be used in the calculation in (c)(ii), and many candidates scored full marks.

Question 8

There was a wide range of marks for (a). Weaker candidates scored the marks for the number of electrons in the respective outer shells and normally the loss and gain of the electron in Group I and VII respectively, but then described different compounds formed by the elements with some of their reactions. The better candidates could relate the increase in reactivity in Group I and the decrease in Group VII as the atomic number and size increases to the decreased attraction between the nucleus and the outer electron, which in turn leads to the Group I metals losing the outer electron more readily and the halogens gaining an electron less readily. It was rare to see any reference to the appearance of the elements.

In part (b), candidates were asked to describe contrasting properties of the reactions between the metals and water and not to simply list observations with each metal, e.g. a flame is seen when water reacts with potassium but not with calcium. Equations were rarely balanced correctly.

In part (c), most candidates understood that eight electrons in the outer shell represents the stable configuration of a noble gas, but only the better candidates then appreciated that the gases neither lose nor gain electrons. The use of argon in light bulbs was well known.

Question 9

In part (a), most candidates knew that allotropes are different forms of an **element**, but failed to score the mark for the existence of the different forms in the same physical state. The marks were withheld if compounds or substances were used instead of element in the definition.

In part (b), candidates had to describe the similarities and the differences in the structures of the allotropes, and not to list similar and different properties. In (iv) candidates had to relate the hardness of diamond and the softness of graphite to the different structures. Macromolecular structures and covalent bonds between carbon atoms were the scoring points in (ii). The tetrahedral arrangement of the atoms in diamond and the layers of hexagons were the differences in the structures in (iii). In (iv), the presence of many strong covalent bonds and the rigid structure of diamond cause the allotrope to be hard, whilst the ability of the layers to slide due to the weak attractive forces between the layers make graphite soft.

There were many full marks to (c)(i), but it had to be made clear that carbon dioxide is formed in a **plentiful** supply or excess of oxygen and not simply a good supply and that a **limited** supply of oxygen is needed for carbon monoxide. Weaker candidates gave monatomic oxygen in the equation for carbon monoxide. When distinguishing between two chemicals as in (ii), candidates must give the observation made with both substances; the answer 'carbon dioxide turns limewater milky' without any reference to carbon monoxide scored only one of the two marks. The equation for reduction of copper (II) oxide by carbon monoxide was well known, but many candidates failed to give the observation of the formation of pink-brown or red-brown copper. Most candidates scored full marks on this calculation. Marks withheld were for arithmetical rather than chemical errors.

Appendix A – Statistics

Grade	A	B	C	D	E
Boundary mark	71	58	45	40	29

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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