

CHEMISTRY

GCE Advanced Level and GCE Advanced Subsidiary Level

Paper 9701/01
Multiple Choice

<i>Question Number</i>	<i>Key</i>	<i>Question Number</i>	<i>Key</i>
1	C	21	B
2	D	22	C
3	B	23	D
4	C	24	A
5	A	25	D
6	A	26	C
7	A	27	C
8	C	28	B
9	B	29	D
10	C	30	B
11	C	31	D
12	D	32	D
13	D	33	A
14	D	34	B
15	C	35	A
16	C	36	B
17	B	37	D
18	C	38	A
19	B	39	B
20	B	40	B

General comments

For this paper, the mean score was 23.0 (57.4%), very near the targeted value of 60%, and the standard deviation of the scores was 7.34 (18.4%), indicating that overall the paper performed satisfactorily.

The first thirty questions were simple completion items: **Questions 31-40** were three-statement multiple completion items.

Comments on specific questions

Three questions – **Questions 9, 22** and **28** – had a high facility, representing areas of the syllabus that were widely understood.

Two questions did not adequately distinguish between the more able and less able candidates. The

relatively high facility of **Question 10** indicated that the acid catalysis of esterification is widely understood, and this led to a low discrimination. **Question 34** was concerned with the dissolution of hydroxyapatite within tooth enamel under acidic conditions, and gave two successive equilibria. There was an indication that some candidates did not appreciate that the reaction of the PO_4^{3-} ion with a proton (in the second equilibrium) would reduce its concentration in the first equilibrium, causing this equilibrium to move to the right with the consequent increase in solubility of the hydroxyapatite.

Question 24 had both a low facility and a low discrimination among candidates: this question tested candidates' understanding of how an alcohol could be dehydrated by concentrated sulphuric acid to give alkenes, and the possible *cis-trans* isomerism of these products. 2-Methylbutan-2-ol gives both $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)=\text{CH}_2$ and $\text{CH}_3\text{CH}=\text{C}(\text{CH}_3)_2$, and neither of these possess *cis-trans* isomerism, yet no less than 58% of candidates believed that there were three possible products.

Question 12 although a valid question this did not perform as well as expected, and was withdrawn from the examination.

All other questions performed satisfactorily but two deserve comment. **Question 16** tested knowledge of the relative ease of thermal decomposition of Group II carbonates by asking candidates to consider the effect of heat on some double salts: the result shows that this novel approach led to many candidates guessing the answer. **Question 18** asked why a mixture of CaO and $(\text{NH}_4)_2\text{SO}_4$ would not be effective in acting both to reduce soil acidity and to be a fertiliser. Whereas 33% of candidates correctly realised that under damp conditions ammonia would be lost, some 46% thought that the significant factor would be that the consequent CaSO_4 would cause hard water.

Paper 9701/02

Theory 1

General comments

Many candidates made good attempts to answer all of the questions, demonstrating sound knowledge and a good understanding of the Chemistry examined in this paper. However, there are still a significant number of candidates whose knowledge, particularly of Organic Chemistry, is poor.

Overall, however, the answers given maintained the improvement in the quality of candidates' performance which has been evident in recent examinations. Most candidates were able to demonstrate some positive achievement.

Comments on specific questions

Question 1

This question tested candidates' understanding of important evidence used in the determination of the electronic configuration of elements. There were a good number of high scoring answers.

- (a) While there were some very clear and accurate answers to this part, there were also many answers that were incomplete or contradictory. Typical of these were answers such as 'It is the energy required to remove one mole of electrons from one atom of an element in the gas phase'.

It is important that definitions of energy changes are unambiguous. In their answers to this question candidates were expected to refer to the energy required for the removal of one mole of electrons from one mole of gaseous atoms.

- (b) This was generally well answered although a significant number of candidates either omitted the state symbols asked for in the question or gave an equation for *first* ionisation energy.
- (c) Most candidates deduced that element X would be in Group V because of the large jump in ionisation energies between the fifth and sixth values. Fewer were able to relate this observation to the sixth electron of element X being removed from an inner shell.
- (d) The question asked for an explanation of the data 'in terms of the atomic structure of the elements'. A significant number of candidates chose to discuss the nature of the bonding within a sample of the element and were penalised as a result. Examiners expected a discussion of the changes in atomic radius, numbers of shells and shielding on going down Group IV and how they influence the ionisation energies. Many candidates referred to at least two of these points but few considered the effect of the increase in nuclear charge which takes place from carbon to tin.

Question 2

A good understanding of bonding and energetics is important and many candidates answered this question well.

- (a) Most candidates drew clear diagrams showing the correct numbers of electrons associated with each atom and the double bond that exists between each of the S atoms and the central C atom.
- (b) The majority of candidates correctly stated that the CS₂ molecule is linear with a S-C-S bond angle of 180°.

Examiners did not accept 'planar' as a correct description of the shape of the CS₂ molecule.

- (c) There were many answers that contained very loosely worded definitions of the term *standard enthalpy change of formation*. Examiners expected candidates to refer to the energy change that occurs when one mole of a compound is formed, under standard conditions, from its elements in their standard states. Examiners did not allow the use of the word 'substance' instead of the word 'compound'.
- (d) There were many correct answers of +119 kJ mol⁻¹. The most common error was to omit to double the value for ΔH_f^\ominus for SO₂.
- (e) A surprising number of candidates struggled with this part. The yellow solid can only be sulphur and this leads to the following equation: CS₂ + 2NO → 2S + CO₂ + N₂. In this equation, the molar ratio of the gases is in the ratio 1:1, as stated in the question.

Question 3

The chemistry of nitrogen is important and there were many good answers to this question.

- (a)(i) Most candidates related the unreactivity of nitrogen to the presence of the N:N triple bond. Unfortunately a significant number made no specific comment about the *strength* of this bond or that a large amount of energy is required to break it, and these candidates were not given full credit for their answers.
- (ii) Most candidates gave a suitable equation although some were penalised for giving unbalanced equations. Conditions were generally clearly and correctly stated.
- (iii) This part was not as well answered. Many candidates did not explain clearly how the conditions they gave would provide enough energy to break the N:N bond or overcome the activation energy.
- (b)(i) Most candidates correctly gave 'fertiliser' as their answer.
- (ii) There were many clear accounts of how eutrophication occurs and what happens as a result. There was, however, a significant number of candidates who either talked about acid rain or who made general comments about pollution and were given no credit for their answers.
- (c) Most candidates correctly identified gas Y as ammonia and were able to give the correct equation for its formation. Even though state symbols were given in the question, a small number of candidates omitted them or gave incorrect ones, and were penalised as a result.
- (d) While many candidates knew that ammonia would react with concentrated sulphuric acid in an acid-base reaction, there were some who thought, wrongly, that ammonia would be oxidised by concentrated sulphuric acid.

Question 4

Understanding the structures of molecules is an important part of AS Chemistry but many candidates continue to be confused when representing the structural formulae of organic molecules.

- (a) Many candidates struggled to explain the term *primary alcohol* in a clear and unambiguous way. The simplest statement Examiners accepted was that a primary alcohol 'is a compound which contains the $-\text{CH}_2\text{OH}$ group'. An alternative definition describes a primary alcohol as having the $-\text{OH}$ group on a carbon atom which is bonded to only *one* other carbon atom – see for example the endorsed text book "AS Level and A Level Chemistry" by Ratcliff et al, published by Cambridge University Press, page 338.
- (b) While there were many candidates who drew three different structures which were correctly labelled, there were also many who confused themselves by drawing the same structure in a slightly different format. A typical wrong answer using, butan-1-ol, the structure of which was given in the question, is shown below:



- (c) The majority of candidates correctly described the colour change as being from orange to green. Examiners did not accept 'yellow' as correctly describing acidified potassium dichromate(VI). There was a significant number of candidates who gave the colour change as being purple to colourless, clearly having acidified potassium manganate(VII) in mind.

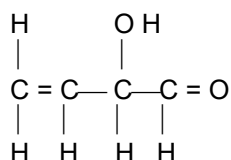
Question 5

This question assessed candidates' ability to interpret the results of specific reactions and gradually deduce the structure of compound **Z**. Examiners were impressed by many of the answers given.

- (a)-(c) While many candidates made sensible deductions, there were also some who did not make their functional group unambiguous.

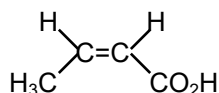
For example, Examiners expected the following answers: (a) alkene *not* double bond; (b) alcohol *not* hydroxyl; (c) aldehyde *not* carbonyl.

- (d) Relatively few candidates were able to give a correct structure involving all of the groups given above *and* including a $\text{H}_2\text{C}=\text{C}$ group so that the compound would *not* show *cis-trans* isomerism. There are three possible correct answers, one of which is given below:



- (e) There were many good attempts at drawing the required structures. Both reactions involved the alcohol group with the formation of an alkoxide with sodium and a methyl ester with ethanoic acid.
- (f) Fewer candidates were able to identify the organic products of the two reactions involving the aldehyde group. With Tollens' reagent, the corresponding carboxylic acid would be formed while with 2,4-dinitrophenylhydrazine, an addition-elimination reaction would take place with the formation of the corresponding 2,4- dinitrophenylhydrazone.

- (g) Many candidates found this part difficult. The structural formula (not displayed) of *cis*-but-2-enoic acid is shown below:



A significant number of candidates failed to draw the *cis* isomer and were penalised. Another common error was for candidates to give a structure containing two carboxyl groups. Such a compound would be called butanedioic acid.

Paper 9701/03

Practical Test

General comments

The Examiners reiterate the general comments made after the June 2005 examination session.

Upon receipt of a packet of scripts, Examiners used the information supplied in the Report on the Examination, the seating plans and the Supervisor's Results to sort candidates into appropriate groups for the award of accuracy marks. Accuracy marks were awarded from a comparison of (Volume of **FA 2** diluted x Titre) for candidate and Supervisor.

The Examiners again thank those Centres where all of the information above was provided and they were able to place each candidate in the correct session and laboratory within that session. *A number of Centres failed to provide sufficient (or any) information.*

- Such Centres are again reminded of the wording in the Confidential Instructions.
- Large volumes of solutions should not be bulked (30 candidates maximum for any one solution).
- Separate Supervisor results should be provided for *each Session and for each laboratory within that Session.*
- *Seating plans* should be provided. (It is often possible to spot and resolve solution/titre problems for a small group of candidates in one part of a laboratory where the seating plan has been provided.)

Where inadequate information was supplied there was the risk that candidates were disadvantaged.

The Examiners noted that the range of ability to perform a titration was considerable. In many cases the candidates were well prepared and performed the titrations efficiently and with considerable accuracy. At the other extreme, some candidates appeared to have little experience of the apparatus used in performing a titration.

The changes taking place during the tests in **Question 2** required close and careful observation. Many observations were consequently missed.

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