

# CHEMISTRY

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## GCE Advanced Subsidiary Level

<b>Paper 8701/01</b>
<b>Multiple Choice</b>

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

### General comments

The first 30 questions were simple completion items: **Questions 31 to 40** were three-statement multiple completion items.

### Comments on specific questions

Only five questions had statistics outside of the design limits.

**Question 2** had a facility just above the design limit, indicating that candidates have a good grasp of the principles of establishing a pattern of occupancy of orbitals. Two questions had a low facility. **Question 32** was based on the kinetic theory of an ideal gas, and perhaps the statements within it, which candidates were asked to state whether they were true or not, were too penetrating: only 13% (key **A**) realized that all three statements were true, whereas 38% chose **B** and 34% **C**, believing one of the statements to be untrue. It may be that candidates have not appreciated the assumptions made within the kinetic theory with sufficient clarity. **Question 34** also had a slightly low facility, and did not discriminate well between the more able and less able candidates: 66% chose the distractor **D**, unaware that the presence of a catalyst can cause a

reaction to proceed through an intermediate which will have a lower activation energy than in an uncatalysed reaction.

**Question 13** was based on the structure and properties of the anhydrous aluminium chloride molecule: whereas 32% of candidates correctly chose **D**, stating that it fumes in moist air, it was surprising to find that 19%, including some of the more able candidates, chose **A**, believing that a covalent  $Al-Al$  bond exists within it, and that 39% believe it to have an ionic structure  $Al^{3+} 3Cl^-$  (**B**). **Question 20** also did not discriminate well: some of the more able candidates chose the distractor **D**, stating that all the C-C-C bond angles within  $(CH_3)_2C=C(CH_3)CH_2CH_3$  were  $120^\circ$ , evidently ignoring the tetrahedral angle within the C- $CH_2CH_3$  side chain.

Aspects of three other questions warrant comment. In **Question 6** 48% of candidates believed  $BF_3$  to be a non-planar molecule. The results of two questions indicate a degree of guessing between options, normally indicating a topic not fully understood. In **Question 8** there was a marked lack of understanding of the standard enthalpy of combustion of graphite and the standard enthalpy of formation of carbon dioxide: these are, of course, identical. In **Question 31** the Examiners had drawn a parallel between the isotopic abundance of an element and the various molecular species within sulphur vapour as seen in a mass spectrum, but clearly its analysis proved too demanding.

References are given to the Assessment Objectives within each section of the Syllabus

Item Number	Assessment Objective	Item Number	Assessment Objective
1	1(g)	21	10.1(b)(iv)
2	2(h)	22	10.2(c)
3	2(i)	23	10.2(d)(i); 1(f)
4	1(b)	24	10.3(a)(i); 10.6(a)
5	3(h)	25	10.4(a)(iv)
6	3(f)	26	10.5(b)
7	4(k)	27	10.5(d); 10.6(a)
8	5(b)(i),(e)(i)	28	10.5(a)(i); 10.2(d)(i),(ii); 10.1(i)
9	6(a)	29	10.6(a)
10	7(h)	30	10.6(h)
11	7(b)	31	1(c)
12	9.1(c)	32	4(a)
13	9.1(i),(j)	33	5(a), (b)(i)
14	9.1(m); 9.2(d)	34	8(e)(i); 5(f)
15	9.4(h)	35	9.1(l)
16	9.4(f)(ii), (c), (d)	36	9.2(a), (b)
17	9.6(g), (i); 6(a)	37	9.4(a), (e)(i), (f)(i); 9.1(l)
18	7(b)	38	9.1(a)(iii), (iv)
19	10.1(b)	39	10.3(c), (d)
20	10.1(c)	40	10.8(a); 1(e); 10.1(c)(ii); 10.2(a)

**Paper 8701/02**  
**Structured Questions**

### General comments

The standard of candidates' answers was generally high, with a good grasp of straightforward equations. Some candidates, however, wrote disappointing answers to the questions on Organic Chemistry.

### Comments on specific questions

#### Question 1

- (a)(b) These two sections are introductory, and were expected to be high scoring. The diagram in section (b) needed to show a regular arrangement of alternatively charged ions.
- (c) Lime absorbs  $\text{CO}_2$  and  $\text{H}_2\text{O}$  vapour from the air, a good example being concrete and cement making, or from horticulture. The candidates did well, possibly thinking about what gases react with  $\text{CaO}$  or  $\text{Ca}(\text{OH})_2$ . The Examiners accepted 'steam' for water vapour. However,  $\text{SO}_2$  is not really a gas of the air, and was allowed one mark only for an equation.

#### Question 2

- (a)(i) The idea of what is meant by *dynamic equilibrium* needs to be taught. Vague answers are never satisfactory.
- (ii) Diagrams tended to omit essential points, chiefly the labelling of the two peaks of the different activation energies.
- (c) The calculation seldom scored full marks. Some candidates omitted the water concentration, i.e.  $[\text{H}_2\text{O}] = 1 \text{ mol dm}^{-3}$  initially. Also, many candidates failed to see that the equilibrium concentration  $[\text{H}_2\text{O}] = 1.57 \text{ mol dm}^{-3}$ . The method of 'error carried forward' was applied as usual, using the candidates' answers to part (i) to determine a  $K_c$  value in part (ii).

#### Question 3

This question was about halogen chemistry, starting with Inorganic and ending with Organic Chemistry. Part (a) was 'knowledge' or 'practical experience', part (b) was 'explanation' and part (c) was 'equations'. The answers to the equations in part (c) still fell short of the Examiners' expectations. The mechanism of the electrophilic addition of bromine to ethane was well learnt, and proved high scoring.

#### Question 4

There were good answers to this question, showing understanding of oxidation numbers and the role of nitrogen in soil. In part (c)(i), calculating  $[\text{H}^+]$  from pH values is not in the syllabus for AS Level, to compensate candidates an extra mark was added to part (e). The usual and expected answer to part (c)(iii) was lime, but ammonia was accepted.

#### Question 5

- (a) Good answers were given for the structures, and alternatives were accepted for parts (ii) and (iv). This made the marking of the rest of the question both flexible and open.
- (b) Orthodox answers to this part would describe and explain optical isomerism, but answers which described structural isomerism were given full marks. For example, using the two structures for part (a)(ii) as follows.



## Question 6

Either candidates scored very high marks here, or they did badly, often not attempting the question. Positive tests were required, as stated on the paper. Oxidising agents, such as acidified  $\text{KMnO}_4$ , or  $\text{K}_2\text{Cr}_2\text{O}_7$  would not distinguish the alcohol or the aldehydes here.

<b>Paper 8701/03</b>
<b>Practical (Written)</b>

### General comments

The Examiners thank those Supervisors who provided full sets of experimental results for **Question 1**, as requested in the preparation instructions.

The Examiners looked for three things in the recording of results in Table 1.1.

- Final burette readings to two decimal places.  
The syllabus outlines the precision expected in reading a burette – to half of the smallest graduation, i.e.  $0.05 \text{ cm}^3$ . Candidates who quote burette readings to smaller intervals are not penalised, but it is disappointing to see a precision stated that cannot be easily justified.
- At least two recorded titres within  $0.10 \text{ cm}^3$ .
- No error in subtraction and a correctly calculated average, or indication of the titres used to obtain the 'average' in the Summary. (For this AS examination, candidates were allowed to tick a single titre with no penalty).

One mark was deducted for any error in the above (no negative marks given).

Accuracy marks for **Question 1** were assessed against the experimental data provided by the Supervisor.

Accuracy marks		Spread Penalty	
Mark	Difference from Supervisor/ $\text{cm}^3$	Range used/ $\text{cm}^3$	Deduction
8	up to 0.10	0.20+ to 0.25	1
7	0.10+ to 0.15	0.25+ to 0.30	2
6	0.15+ to 0.20	0.30+ to 0.40	3
5	0.20+ to 0.30	0.40+ to 0.50	4
4	0.30+ to 0.40	0.50+ to 0.60	5
3	0.40+ to 0.60	0.60+ to 0.80	6
2	0.60+ to 0.80	0.80+ to 1.00	7
1	0.80+ to 1.00	Greater than 1.00	8
0	Greater than 1.00		

The spread penalty was applied to candidates who used titration values more than  $0.20 \text{ cm}^3$  apart in calculating their 'average'.

A significant number of candidates obtained very good titration results but used no judgement as to which should be used to calculate the average'. As the Examiners are looking for any two titres within  $0.10 \text{ cm}^3$ , it is recommended that candidates are taught to stop titrating when they have two such values and to use them in the calculation of the 'average'.

It would still appear that, in some Centres, the Supervisor titration is performed at a different time to the candidates, as the results provided by the Supervisor bear little relation to those produced by the majority of candidates. In such cases, the Examiners attempt to find the best 'standard' from the candidates results but this is not always possible. **The Supervisor results should be obtained at the same time and under the same conditions as experienced by the candidates in the examination.**

Thank you to those Centres that provided accurate seating plans and Supervisor results for each session and laboratory. Where this information exists, it is often possible to spot problems with batches of solution and to take action which benefits the candidates.

When Supervisors are asked to provide a set of experimental results, the Examiners would appreciate seeing a complete set of titration results with all final and initial burette readings completed. It is not impossible for Supervisors to make an error in subtraction in the titration table. Where complete burette readings are not given, it is not possible for Examiners to check the values and there is the possibility of candidates being disadvantaged.

There was little evidence of candidates running short of time.

### Comments on specific questions

#### Question 1

The majority of candidates scored maximum marks for the completion of table 1.1.

Burette readings were recorded to 2 decimal places, subtractions were correct and sufficient titrations undertaken. Selection of a suitable titration value to use in the calculation was less well done. A common error was to fail to indicate the volumes being used to obtain this value.

The marks awarded for accuracy were generally high. The Examiners were pleased to note a continuing improvement in the quality of titration work by many candidates.

The majority of candidates were able to gain some marks from the calculations and many gained most of the marks.

Most candidates are now familiar with the equation,  $\text{No. mols} = \frac{\text{vol in cm}^3 \times \text{concentration in mol dm}^{-3}}{1000}$ , and were able to correctly use the mole ratio from the balanced chemical equation. The remaining steps in the calculation became more difficult for some candidates.

#### Question 3

**FC 3** was a solution containing  $\text{Pb}^{2+}$ ,  $\text{Zn}^{2+}$  and  $\text{NO}_3^-$  ions.

The Examiners were looking for

Test	Observations [5]	Deductions [4]	
(a) To 2 cm depth of <b>FC 3</b> in a test-tube, add dilute nitric acid.	No reaction No colour change No precipitate No gas evolved <b>one mark</b>	Not $\text{CO}_3^{2-}$ , $\text{SO}_3^{2-}$ or $\text{NO}_2^-$ <b>one mark</b> This deduction can only be made from no reaction or no gas (evolved)  (No $\text{CrO}_4^{2-}$ is wrong – colour)	<b>2</b>
(b) To 2 cm depth of <b>FC 3</b> in a boiling-tube, add aqueous sodium hydroxide.  Warm the solution.	White precipitate Soluble in excess (from both observations) <b>one mark</b>  No ammonia <b>or</b> no positive test for ammonia described <b>one mark</b>	$\text{Al}^{3+}$ , $\text{Pb}^{2+}$ or $\text{Zn}^{2+}$ <b>one mark</b> (from both observations)  No $\text{NH}_4^+$ <b>one mark</b> Allow this deduction from no gas (evolved) or gas having no effect on litmus paper	<b>4</b>

<p>(c) Cool the solution remaining from test (b), add aluminium foil and cautiously warm again.</p>	<p>Ammonia <b>one mark</b> Test for ammonia described <b>one mark</b></p>	<p><math>\text{NO}_3^-</math> or <math>\text{NO}_2^-</math> <b>one mark</b></p>	3
<p>(d) To 2 cm depth of FC 3 in a test-tube, add aqueous potassium iodide.</p>	<p>Yellow precipitate <b>one mark</b></p>	<p><math>\text{Pb}^{2+}</math> <b>one mark</b></p>	2
<p>(e) To 2 cm depth of FC 3 in a boiling-tube, add dilute aqueous ammonia until in excess.</p> <p>Filter the mixture and then add dilute nitric acid drop by drop to neutralise the solution and then in excess.</p>	<p>White precipitate. <b>one mark</b> <i>Ignore solubility of the white precipitate</i></p> <p>White precipitate.</p> <p>Soluble or partially soluble (excess). <b>one mark</b> <i>(from both observations)</i></p>	<p><i>Ignore any ions from white precipitate</i></p> <p><math>\text{Zn}^{2+}</math> <b>one mark</b></p>	3

- (a) Comparatively few candidates were able to make a meaningful deduction after observing and recording no reaction. When practising observation and deduction exercises it is suggested that, where no gas is seen on adding the acid at the beginning of a test, candidates should be taught to conclude no carbonate, sulphite or nitrite as this point is very often missed.
- (b) Most candidates obtained the observation and deduction marks for the white precipitate but many missed the significance of warming the solution containing sodium hydroxide. Whenever an unknown is warmed with aqueous sodium hydroxide the question should be asked – is ammonia evolved?
- Definite deductions can be made from tests where there appears to be no reaction. This statement, in bold type inside a box, has been included in recent papers. Most candidates still missed the absence of ammonia and of an ammonium salt.
- (c) The significance of warming with sodium hydroxide and aluminium foil was missed – despite its prominent position in the analysis notes. Many candidates did detect ammonia here (one mark) but deduced that an ammonium salt was present.
- (d) This test enabled most candidates to deduce the presence of the lead cation.
- (e) Most candidates obtained the first mark in this test. The second part of the test, as usual, discriminated between those who followed the instructions carefully and those who added reagents quickly or in too large a quantity. The re-precipitation of zinc hydroxide and its subsequent solubility in excess nitric acid is only seen over a very narrow pH band.

One mark was given for correctly identifying, in the Summary, all three ions present so was only gained by those who had been careful in their practical work.

There were 25 marks for the paper and a number of candidates scored maximum or near maximum marks.