CHEMISTRY

GCE Ordinary Level

Paper 5070/01
Multiple Choice

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

General comments

Almost all the questions discriminated well and only one question, **Question 35**, was found to be easy by all the candidates. The stem to each question is kept to a minimum and hence every word in the stem is of significance. Consequently it is very important that candidates read the questions carefully.

Comments on specific questions

Question 4

The most popular distractor was **C**. In sodium chloride the co-ordination number of the sodium ion is six, since it is not only the chloride ions in the same plane as the sodium ion but the chloride ions immediately above and below the sodium ion which are in contact with the sodium ion.

Question 7

Alternative **A** was very popular indeed due probably to the candidates not reading the question carefully enough. Calcium is in the same Group of the Periodic Table as strontium and calcium and strontium ions do have the same charge. However neither their atoms or their ions have the same electronic configuration.

Question 28

Alternatives **A** and **C** did not work and in general candidates chose either alternative **B** (the correct answer) or alternative **D** (the incorrect answer). The key to the answer being that -200°C is a lower temperature than the boiling points of argon, nitrogen and oxygen and thus they would not exist as gases at this temperature.

Question 29

Ammonium phosphate, $(NH_4)_3PO_4$, the correct answer was surprisingly unpopular possibly due to the compound being unfamiliar.

Question 31

Two alternatives **C** and **D** were given as answers with almost equal regularity. The formula for sodium sulphate is Na_2SO_4 and a solution of it will always contain twice as many sodium ions as sulphate ions.

Question 33

Essentially this question involved factual recall. Consequently the use of sulphur dioxide as a food preservative should have quickly eliminated the commonly given alternatives **C** and **D** from the possible answers.

Question 34

The molecular formula for each of P, Q and R was C_3H_8O making them isomers of each other and D the correct alternative. The isomers Q and R were both alcohols and P was an ether which led the majority of the candidates to suggest that P was not an isomer of Q and R because it was not an alcohol.

Question 40

When a carbon double bond is broken in a reaction with bromine each of the carbon atoms involved in the double bond gains a bromine atom making **C** the correct answer. For alternative **D** to be correct a hydrogen atom would have had to leave the end carbon atom and bond to the second carbon atom in the molecule.

Paper 5070/02
Theory

General comments

A full range of performance was seen from candidates. Some exceptional candidates achieved almost full marks. The candidates appeared to use their time well. A small minority of candidates left blank spaces or did not attempt three ***Section B*** questions, but such occurrences were rare. Candidates answered longer questions well. Most candidates showed skills in answering longer questions by attempting to write separate answer points to match the number of marks for longer part questions.

The paper revealed very good understanding of syllabus chemistry in some areas. Candidates showed a very good grasp of areas such as atomic structure, organic chemistry, rates of reaction and calculations. Two questions asked candidates to predict observations. Contrary to the evidence of previous years, candidates answered such questions very well, suggesting an improvement in observational skills.

Candidates performed less well at writing equations. The commonest error seen was due to incorrect balancing, although in many cases the formulae of the substances involved were correct. Confusion about bonding was evident in the work of some candidates across the paper. Fewer very high scores were seen for ***Section B*** questions than have been seen in previous years.

Many Examiners commented on the need for using the lined pages provided for answering ***Section B*** questions. Some candidates are including part answers on pages where the questions are printed. This should be discouraged, because answers not on the lined pages may be mistaken for rough work.

<u>Comments on specific questions</u>

Section A

Question 1

(a) This part was very well answered. The only common error was that some candidates thought that distilled water would conduct, leading to the bulb lighting. Candidates need to be reminded that if they give a list which includes extra wrong answers, e.g. **A** (correct) **B** (correct) and **D** (incorrect) they will not score full marks (in this case, 1 mark would be scored).

(b) The labels on the diagram were not always clear. Many candidates wrote 'anode' and 'cathode' on each side of the beaker, but did not draw lines to show clearly what the words were meant to refer to. Such answers did not score. For part **(ii)**, if a transition metal halide was named, it was essential that the oxidation number was included for a mark to be awarded, e.g. copper(II) chloride (correct), copper chloride (no mark). For part **(iv)**, many candidates discussed moving electrons rather than ions in the molten state, showing confusion between ionic and metallic bonding.

Question 2

All but the weakest candidates scored all five marks here, showing excellent understanding of atomic structure and also very high level skills in comprehension of tabulated information.

Question 3

This question was the most poorly answered of the ***Section A*** questions. In attempting to define 'allotropes', many candidates showed confusion between allotropes and isotopes. Similarly, many candidates described a polymer rather than a macromolecule for part **(ii)**. In discussing the lubricating properties of graphite, many candidates knew that a sliding effect was important, but did not clearly mention that it is the layers in the structure which slide. Many thought that individual atoms could move. The use of diamonds in drill bits and cutting tools was well known.

Question 4

(a) This part tested the ability of candidates to predict observations. In previous years, this type of question has tended to be poorly answered. However, the quality of responses here was very good. Most candidates knew that 'fizzing' would be seen or that the potassium 'moves around on the surface of the water'. The improvement here shows that candidates have improved their skills in this area. Answers such as 'hydrogen is given off' did not score, as such statements are not true observations.

(b) The ionic dot and cross was well answered, the commonest error being to omit the charges on each ion.

(c) This part was well answered, although some gave '55' as the number of electrons in the outer shell, suggesting that they had not read the question properly. CsO was sometimes given as the formula of caesium oxide, and some thought that caesium oxide was produced from the reaction of caesium with water.

(d) Almost all candidates realised that the position of the element in group I was important, but only the best candidates linked this to atomic size or ease of loss of the electron for the second mark. Vague answers, such as 'caesium is more reactive', were not considered credit worthy.

Question 5

(a) Most candidates could identify fluorine as the oxidising agent, showing a good understanding of redox. Many only scored one mark for part **(ii)**. Common errors were to only give information about either fluorine or hydrogen, rather than both, or to *state* that hydrogen is oxidised and fluorine is reduced without going on to *explain* this in terms of oxidation number or electron transfer.

(b) This part tested the candidates' ability to reason in an unfamiliar situation. The question was well answered, although some did not link the increase in molar *amount* to the production of a higher gas *volume* for part **(ii)**. Almost all candidates recognised that r.t.p. would not apply to the different conditions of temperature and pressure in the rocket, but some wrongly believed that 'gas calculations do not apply to large amounts of gases'.

Question 6

(a) This question was well answered, revealing a sound understanding of organic chemistry. The mark scheme for the graph was generous in allowing a broad range of acceptable values for the extrapolated graph. A fully correct response would be to draw a curve and extrapolate to about 69ºC. Weaker candidates lost marks because the negative values of −88ºC and −42ºC were often plotted incorrectly. Some candidates did not extrapolate smoothly, but produced a curve which flattened in a similar way to a rate curve. Some gave a value of the boiling point of hexane without the units 'ºC' and so did not score that mark.

(b) This part was very well answered, with almost all candidates producing general formulae for alkanes ($C_nH_{(2n+2)}$) and alkenes (C_nH_{2n}).

(c) This part was very well answered. The commonest reason marks were lost was through failure to balance the equation. Candidates revealed a detailed knowledge of the hazards of carbon monoxide, often giving a full explanation of the irreversible reaction with haemoglobin. The pollutants from car exhausts were well known.

Section B

Question 7

(a)(b) This question was a popular choice and was generally well answered, showing a good understanding of the chemistry of rates of reaction. The calculation was well done by better candidates. Common errors were to forget to divide by 1000 to allow for the concentration, or to forget to divide by 2 to allow for the reacting ratios. Some failed to score the mark for explaining how the rate of reaction changes. Common errors were to discuss how the *volume of hydrogen* changes, which does not answer the question. Others believed that the rate 'slows and *becomes constant*'.

(c) The equation was straightforward and well done by all but the weakest candidates, the commonest error being to give Zn_2SO_4 as the formula for zinc sulphate. The last part of this question showed a wide spread of answers and achievement. Some candidates believed that, as the concentration of the sulphuric acid was the same, it would react identically to hydrochloric. Better candidates realised that the dibasic nature of sulphuric acid would lead to a faster reaction with more hydrogen produced. Some showed this by calculation. Only the best candidates correctly identified that it is the increase in concentration of H^+ ions that leads to an increased rate of reaction.

Question 8

This question was also a popular choice, but marks were not as high as for **Question 7**. A surprising number of candidates stated using sugar and yeast, but did not mention that there needs to be water in flask A. The conditions needed for fermentation were not very well known. Many correctly stated that the absence of air was important, but far fewer gave a reasonable optimum temperature. 'Room temperature' was often stated. Some candidates gave a fully correct symbol equation for the fermentation which was, of course, acceptable. All knew that lime water is used to test for carbon dioxide. The equation for the combustion of ethanol was usually correct, the commonest error being, again, mistakes in balancing. The calculation was well done. Errors were sometimes seen in the calculation of the molecular mass of ethanol. In such cases, some credit was given for 'error carried forward'. The structures for ethene and ethanol proved problematic for some candidates who gave either too many, or too few hydrogen atoms. Some showed a double bond to the oxygen in ethanol. A few gave the structure of ethanoic acid.

Question 9

Very few candidates recognised that this is an example of a precipitation reaction. Common wrong answers were 'displacement', 'exothermic' and 'purification'. The ionic equation was usually correct, with some weaker candidates making errors in the charges on the ions. All knew that the calcium carbonate could be removed by filtration. The electrode half equations for the electrolysis reactions were better attempted in previous years, with far fewer errors in balancing or equations being written 'back to front'. At the cathode, credit was given for equations which showed hydrogen or a sodium amalgam produced. The calculation was well done by better candidates. Common errors were to forget to convert kg to g, leading to an error of a factor of 1000, or to forget to divide by 2 to take into account the diatomic nature of chlorine. The dot and cross diagram was usually correct, the commonest error being to omit the 6 non-bonding electrons around the chlorine atom.

Question 10

This was the least popular of the ***Section B*** questions. However, candidates who attempted this question tended to score well.

(a) Better candidates recognised that the reactions were displacement reactions and correctly suggested reacting magnesium with aqueous copper(II) sulphate and chlorine with aqueous potassium iodide. The equation for the halogen/halide reaction caused difficulties for some candidates who failed to balance it properly. The commonest reason for losing marks was for giving incorrect observations, e.g. a purple solution of iodine is formed. Observations for the metal displacement reaction were usually correct, with many candidates stating that the blue solution would decolourise and that a brown precipitate would form. The most able candidates earned an additional mark by detailing a negative test, e.g. mixing iodine with potassium chloride, to confirm the result. Weaker candidates confused the reactions, believing that a displacement would occur on mixing two solutions such as aqueous copper(II) sulphate and magnesium nitrate.

(b) Some candidates gave the order of reactivity in *descending* order, suggesting they had not read the question carefully. Most could identify the three metals, although some believed that sodium or potassium was extracted from the electrolysis of the oxide, rather than the correct answer, aluminium.

Paper 5070/03

Practical Test

General comments

The overall standard was highly commendable and candidates are to be congratulated on the way they tackled two difficult exercises. Only a minority of candidates were unable to demonstrate significant practical skills.

Comments on specific questions

Question 1

(a) Candidates were required to measure the temperature changes when 5 cm^3 portions of hydrochloric acid were added to 50 cm^3 of aqueous sodium hydroxide. 2 marks were awarded when the reported values were within 0.5°C of the Supervisors' values (1 mark for a value within 1.0°C). These marks were awarded for the first 6 portions of acid only.

The majority of candidates scored 9 or more marks (out of 12) with many achieving full marks. Candidates were asked to measure the temperatures to the nearest 0.5°C and this did not appear to cause problems. Candidates were penalised for subtraction errors, although these were uncommon, and for recording incremental temperature changes rather than the total temperature change that was required. However in both cases the 'accuracy' marks were awarded on the corrected values.

The only disappointing feature of this part of the examination was that a significant number of candidates had clearly altered their original results to 'improve' them and make them fit the graph. In almost all cases this led to a loss of marks, often a significant loss. Candidates should always be encouraged to record their actual values rather than attempting to guess the correct answer.

(b) Very few candidates failed to plot the points accurately, and most drew two straight lines which intersected. A disappointing number failed to recognise that one of the lines must pass through the origin (especially as this was given in the table) and a number 'forced' the line through a convenient point (usually 25 or 30 cm^3).

(c)(d) Candidates were then required to use the graph to measure the highest temperature reached and the corresponding volume. Although many achieved this successfully, there was a significant number who failed to read the scale correctly (20.5 read as 25 for example) and others who gave a result from the table rather than from the graph. Where candidates had drawn a single curve, they were expected to give the values corresponding to the maximum. Where the graphs were difficult to interpret, candidates were given the benefit of the doubt wherever possible.

(e) The calculation was usually well done, with answers expected to at least 2 significant figures. There were a few examples of candidates either using a mole ratio of 1:2, rather than 1:1, or of misreading the question and calculating the concentration of the acid, using a concentration of 2.0 mol/dm^3 for the sodium hydroxide.

(f) Candidates were then required to add the same volume of acid (obtained from the graph) to 50 cm^3 of a second alkali and to measure the temperature change. Again this was marked with reference to the values given by the Supervisors, using the same limits as in part **(a)**. This proved more difficult than part **(a)**, but again most candidates scored at least one of the two marks available.

(g) Although one would expect the temperature change with the second base to be less than with the sodium hydroxide, this part of the exam was marked consequentially. As the bases had the same concentrations, the one producing the higher temperature change is the more alkaline and has a higher pH. Candidates found this much more difficult than expected, with many 'ticking' the acid values and others having several attempts before settling on their final answer.

Question 2

Although this was thought to be a demanding exercises candidates coped well, with many producing answers which would not have been out of place in an higher level examination. As is usually the case, marks were lost for incomplete rather than incorrect observations although it was not necessary to make all the observations to score full marks. It was encouraging to see most candidates using the correct terminology, precipitate rather than deposit, residue etc. for a solid produced during a reaction.

Test 1 When aqueous sodium hydroxide is added to S (nickel sulphate), a green precipitate is formed, this precipitate is not soluble in excess sodium hydroxide. Most candidates correctly saw these changes, although a few either thought the precipitate was white, or that it dissolved in excess.

Test 2 With aqueous ammonia, the nickel sulphate gives a blue precipitate which does dissolve in excess to produce a darker blue solution (although not as blue as that obtained with copper(II) sulphate). A number failed to notice the formation of a precipitate, which is quite faint, but they were able to gain credit for reporting the colour changes of the solution, the initial green solution becoming first blue and then dark blue.

Test 3 When aqueous barium nitrate is added to **S** a white precipitate is formed. Letting the mixture stand for a few minutes, allows the precipitate to settle and makes it easier to see that it is white and not green. The addition of nitric acid, does not cause the precipitate to dissolve. Most candidates reported all of these observations, with only a few thinking that the initial precipitate was green or that it dissolved in the acid.

Test 4 When aqueous sodium chlorate(I) is added to S, there is an instantaneous reaction producing a precipitate that starts of as yellow/green and rapidly becomes black. All these observations were required, although any reasonable description of the initial colour was acceptable. Candidates who described the solution as changing colour, rather than the precipitate, gained some credit.

On heating effervescence takes place and chlorine is produced, bleaching litmus paper. All three statements were required. A large number of candidates lose marks by reporting only one or two of these observations.

A number of candidates detected sulphur dioxide, presumably confusing the smells of the two gases.

Test 5 When hydrogen peroxide is added to the mixture from Test 4, vigorous effervescence takes place, producing oxygen which re-lights a glowing splint, again all three statements were required. A number of candidates claimed carbon dioxide was evolved both in Test 5 and in Test 4.

The black precipitate also disappears to be replaced by a slightly cloudy green solution. Candidates were expected to describe this change as accurately as possible.

Conclusions

The formation of a white precipitate in Test 3, which does not dissolve in acid, confirms that the anion in S is a sulphate. Candidates were asked for a formula and therefore only SO_4^{2-} was acceptable. A precipitate of any colour in Test 3, provided it did not dissolve in acid, allowed the conclusion mark to be scored.

Chloride was a relatively common incorrect answer, based presumably on the chlorine in Test 5, carbonate and nitrate were less common and a few candidates gave a cation, usually iron(II).

Paper 5070/04

Alternative to Practical

General comments

The Alternative to Practical Chemistry Paper is designed to test the candidate's knowledge and experience of practical chemistry.

Skills expected, include recognition of chemical apparatus and their uses, recall of experimental procedures, handling and interpretation of data, analytical testing, and calculations. The standard in general is being maintained and a large majority of candidates showed evidence of possessing most of the aforementioned skills.

Most candidates show competency in the plotting of graphs, however, in this examination in particular, a significant number of candidates failed to follow the instruction of continuing the curve to meet the vertical axis.

Comments on specific questions

Question 1

The diagram shows a syringe.

Question 2

This experiment involves the heating of blue copper(II) sulphate crystals to produce white anhydrous copper(II) sulphate.

The correct numerical answers are: **(b)** 3.85g; **(d)(i)** 2.50g, **(ii)** 1.35g; **(e)(i)** 160, **(ii)** 18; **(f)(i)** 0.0156, **(ii)** 0.075; **(g)(i)** 4.81, **(ii)** $CuSO_4.5H_2O$.

Marks were lost for rounding up e.g. in **(f)** 0.0156 becomes 0.016 and 0.075 becomes 0.08. The first mark in **(g)** is for a correct calculation of **(f)(ii)** divided by **(f)(i)** and the final answer must show the nearest whole number to the answer from **(g)(i)**.

Question 3

In **(a)** the error in setting up the apparatus was the direction of the water flow in the condenser, which should have been in the reverse direction.

Apparatus A and B are a fractionating column and a condenser respectively. The reasons for use are to separate the vapour/mixture and to change vapour to liquid. Answers which involved the name of the apparatus in the answer lost the mark e.g. a condenser is used to condense the vapour.

In **(d)** the electric heater was used as the hydrocarbons were both inflammable.
The reading in **(e)** on the thermometer was 80°C when the first distillate, benzene, first appeared. The indication that this fraction was complete was the observation of a rise in temperature.

The answers to **Questions 4** to **8** were **(c)**, **(a)**, **(d)**, **(b)**, **(b)** respectively.

Question 9

In **(a)** the mass of iron was 1.65g. In **(b)** the air must be excluded from the apparatus to prevent the oxidation of the Fe^{2+} ions to Fe^{3+} ions. This was a very difficult question to the majority of the candidates, the most common incorrect answer being the need to prevent the iron from rusting. The gas evolved in **(b)(ii)** is Hydrogen, which is positively tested by the production of a `pop' with a flame or lighted splint. The use of a glowing splint is not acceptable.

In **(c)** the colour change at the end point is colourless or light green to pink or purple. This again was incorrectly answered by many of the candidates the majority of which noted the correct colours but in reverse.

For **(d)** the correct volumes of potassium manganate(VII) used were 27.8, 26.4, and 26.6 giving a mean value to be used in the calculations of $26.5cm^3$. In the case where incorrect readings were made the candidate was awarded a mark for a mean volume appropriate to these incorrect volumes.

The answers to the calculations are **(f)** 0.000532; **(g)** 0.00266 (5 x the answer from **(f)**); **(h)** 0.0266; **(i)** 1.49g; **(j)** 90%. In all calculations any error in one part may be correctly used in subsequent parts. Arithmetic approximations are also penalised.

Question 10

This question involves the analysis of the salt zinc chloride $ZnCl_2$.

Test 1 should show a colourless solution. The word clear is unacceptable, as also is any reference to precipitates and substances.

Both **tests 2** and **3** produce white precipitates, which are soluble in excess.

Test 4 requires the addition of aqueous silver nitrate and nitric acid to produce a white precipitate. Errors included using hydrochloric acid as the acid, which invalidates the test, and use of “acidify” without reference to a named acid was penalised.

Question 11

The correct temperatures were 80, 56, 39 and 26 respectively. The common error was reading the thermometers as 50.6, 30.9, 20.6. Although the reading marks were lost the candidate could obtain the plotting marks on the graph using these incorrect values. Candidates generally plotted the points correctly and followed the instruction to continue the curve to meet the y-axis. However a large number spoilt their curve by bending it to enable it to pass through zero.

Answers to parts **(c)**, **(d)** and **(e)** were marked on the candidate's reading of their own graph. Typical answers were **(c)(i)** 35, **(ii)** $142g/100cm^3$; **(d)** 60°C; **(e)** 64g.

Part **(e)** required the candidate to first read the solubility at 50°C which was $86g/100cm^3$ and then subtract it from 150g to give the answer of 64g.

When reading a candidate's graph, marks were awarded if the candidate's reading was within one half of a small square of the true reading.