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FOREWORD

This booklet contains reports written by Examiners on the work of candidates in certain papers. **Its contents are primarily for the information of the subject teachers concerned**.

CHEMISTRY

GCE Ordinary Level

Paper 5070/01
Multiple Choice

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

General comments

The questions in general proved a good test of knowledge and ability providing a satisfactory distinction between candidates of a different chemical ability.

Comments on specific questions

Question 1

Tap water has chemicals added to it to provide beneficial additives as well as destroying harmful bacteria. Thus tap water is not a pure compound.

Question 3

Oxygen and bromine molecules would diffuse in the gas jars shown in the diagram, but not at the same rate, thus the much favoured option **C** was incorrect. The rate of diffusion of gases is dependent on the relative molecular masses of the gases involved.

Question 7

The key to answering the question was the number of electrons each atom had in its outer shell before combination with other atoms. Therefore **Y**, which had six electrons in its outer shell, before combination, had to be in Group VI of the Periodic Table, i.e. oxygen or sulphur from the list. Atoms of **Z** had seven electrons in their outer shell, before combination, and therefore were in Group VII and must be the element chlorine. The only possible combination fitting the above criteria was sulphur and chlorine.

Question 11

Half of the entry thought that the answer to the question was **C**, failing to realise the importance of the word 'volume'.

Question 18

Insoluble salts are usually prepared by mixing together solutions of two salts or bubbling a gas through a solution of a soluble salt. Consequently, a solution of copper(II) sulphate and solid insoluble magnesium carbonate, a common answer, could not be used to prepare insoluble copper(II) carbonate.

Question 32

The actual structure or formula of cholesterol was not necessary, all that was required was the realisation that the names of alcohols always end in 'ol'.

Question 35

All proteins contain the element nitrogen, and since option **B** was the only alternative containing nitrogen, **B** had to be the answer.

Paper 5070/02
Theory

General comments

Candidates showed a range of achievement. Most presented their work very clearly and correctly crossed out answers if they chose to amend them. There were far fewer problems caused by the use of correction fluid than in previous years. Some candidates showed a sound grasp of chemistry from across the syllabus. Areas that were particularly well understood this year included soil pH and fertiliser use, homologous series, handling of formulae and equations and reactions of halogens.

Most candidates made good use of their time during the examination. However, many candidates omitted parts or sometimes even whole questions which, of course, limited the score they could be awarded.

Questions that asked for 'advantages' or 'disadvantages' required specific answers given in scientific language. For example, in **Question 2 (d)** (advantages and disadvantages of using nylon for fishing nets) answers such as 'cause pollution' or 'dangerous to sea life' are too vague and do not score. Better answers are more specific, for example 'non-biodegradable' or 'made from a non-renewable raw material (crude oil)'.

Calculations continued to be well attempted generally, but many Examiners commented that the standard seemed to be poorer than in previous years in this area. Candidates need to set out their working clearly so that partial credit can be given for an incorrect final answer. They should also remember to always state their units clearly. Answers given without full working shown do not score full marks, even if correct. Candidates need to check that any molecular masses that they calculate are correct. Minor errors can 'carry through' a whole calculation. Another common error this year was incorrect rounding of recurring numbers.

Two questions on ***Section B*** this year had part questions with large mark allocations. Candidates needed to plan their answers carefully to ensure that they made enough separate points to access all of the marks. Any plans made in the answer booklet should be crossed through so that the Examiner does not mark rough work.

Candidates need to take especial care when answering ***Section B*** questions that they carry out all the tasks in each part question. A common error this year was to leave parts of questions unanswered, for example omitting the overall equation and/or gas tests in **B10** part **(b)(ii)**.

Where candidates were asked to suggest reagents for an experiment (for example in **B10** part **(c)**), answers that suggested using substances that would lead to reactions that are unsafe to handle under normal laboratory conditions (for example sodium and sulphuric acid) were not accepted as correct.

Comments on specific questions

Section A

Question 1

This question was well answered, with few candidates scoring less than four of the six available marks. Candidates usually find questions which require selection and recognition straightforward. This was intended as an easy 'starter' for the paper. Part **(d)** was the only part which commonly posed difficulties for the candidates. Many thought **A** and **B** would produce the compound of formula type YZ_2.

Question 2

(a) Most knew which polymer was an amide and which was an ester, but many were not able to identify the atoms in the linkage. Such answers gained one of the two available marks.

(b) Almost all gave proteins as natural polyamides, although some said 'nylon'.

(c) This was the first more difficult question in ***Section A***. Most knew that the monomers of terylene would have the functional groups COOH and OH at each end. Common errors were to give the hydrocarbon centres the wrong way around, or to give the wrong hydrocarbon centres. Some copied the nylon monomer functional groups, giving NH_2 at each end of one of the molecules.

(d) As mentioned in the general comments above, the main difficulty here is that many candidates answer advantage/disadvantage questions in very vague terms, rather than giving specific scientific answers. Vague answers do not score, for example *'lasts a long time'* was not accepted, but *'lasts a long time because it is non-biodegradable'* was given full credit.

Question 3

(a) Most candidates correctly interpreted the information to give 5.0 – 5.9 as the pH range. A few incorrectly gave the whole range for peanut growth (5.0 to 6.5).

(b) All gave mango.

(c) This question revealed some partial understanding of the roles of the two compounds. Most knew that compounds are added to the soil to increase its fertility, but some did not know which the essential elements are. This led to calcium hydroxide being identified as a fertiliser, and both calcium and sulphate ions being mentioned as essential elements for plant growth. Many knew that calcium hydroxide affected soil pH, but not all stated this clearly. Common poor answers included, *'reduces soil pH'* and *'neutralises the ammonium sulphate'*. The mark scheme for the role of ammonium sulphate gave a list of many possible alternative answers. Common easy marks were given when candidates identified that this is a fertiliser that increases plant growth. Fewer identified the compound as a source of nitrogen. 'Gives nitrate ions' was not given credit (there are no nitrogen ions in ammonium sulphate) but 'reacts in the soil to produce nitrogen ions' was allowed (the wording of the mark scheme did not insist on a mention of the role of bacteria).

(d) The two formulae were well known (although some gave the formula of ammonia as 'NH_4') , but fewer remembered to balance the equation by giving '2' NH_3. In part **(ii)**, there was confusion about the outcome of the reaction. Some focused on the output of ammonia in the equation and tried to explain a disadvantage to this, for example, 'ammonia is formed and makes the soil alkaline,' 'ammonia is formed and creates a smell/hazard that affects farm workers'. Few correctly stated that the reaction results in a loss of nitrogen from the added fertiliser.

Question 4

(a)(b) Most candidates gave the correct names for the two acid chlorides. Mis-spelt names were not given credit. This was because the name 'pentanoyl chloride' was given in the table, and the skill of naming 'propanoyl' from data interpretation was being tested in **(b)**.

(c) Deriving a general formula for an unfamiliar homologous series proved very difficult for most candidates so that this question worked as a discriminator for the most able. Some candidates did not keep the '$COCl$' group separate, but tried to add the carbon atom into the alkyl group, thus giving answers such as '$C_xH_{(2x-1)}OCl$' or '$C_{(x+1)}H_{(2x-1)}OCl$'. Others missed the carbon atom out of an otherwise fully correct formula.

(d) All knew that carbon dioxide and water (or steam) are the products of complete combustion of alkanes, but fewer correctly stated that the products of combustion of acid chlorides would be different due to the presence of chlorine. Many thought that the products would be the same, as both sets of compounds are homologous series and 'the products of complete combustion are always carbon dioxide and water'.

Question 5

(a) State symbols posed no problems for most, although there was some confusion between the use of (aq) and (l). Some thought that calcium carbonate was an aqueous solution. The calculation proved difficult for many candidates. This is a standard type of calculation and many Examiners commented that fewer candidates than expected were able to work to give the correct answer.

(b) Not all realised that a reduced initial rate implied a reduced initial concentration, but most understood that there must be fewer moles of acid present overall to give a reduced volume of hydrogen at the end. Thus answers such as '0.75 mol/dm^3 and 12.5 cm^3' earned a single mark (correct concentration, incorrect volume) and also '1.5 mol/dm^3 and 12.5 cm^3' was awarded one mark because, although the concentration is incorrect, the combination of these values gives a reduced number of moles of acid present.

(c) Most correctly named calcium sulphate, but very few realised that this salt is insoluble and so stops further reaction. The commonest error was to state that the calcium carbonate was 'used up quickly'. Very few recognised that the dibasic nature of sulphuric acid results in a higher concentration of hydrogen ions, leading to an increased rate of reaction. Common wrong answers discussed acid strength, for example saying that sulphuric acid is more fully dissociated than hydrochloric. Any mention of acid strength shows confusion between acid strength and hydrogen ion concentration and such answers were not given any credit. Some candidates thought that, as the rate of reaction increases sulphuric acid must be acting as a catalyst.

Question 6

(a) All of part **(a)** was well answered, but the calculation again caused some difficulties. Candidates should note that it is important to always give the sign when giving an oxidation state, i.e. '+1' not '1' alone. In the calculation, a common error was caused by wrongly rounding the value of 88.888 recurring. Many candidates rounded this to '88.8%' rather than the correct '88.9 %', hence losing a mark. Another common error among weaker candidates was to make errors in calculating the relative masses of either the copper content or the total molecular mass of the compound. Where the working was clearly shown, such answers were able to gain partial credit for method.

(b) This question was intended to be straightforward. Many candidates had unexpected difficulties in drawing the electronic structure of the sulphide ion. Common errors were in mis-labelling the ion as 'SO_3' or 'SO_4' rather than 'S'. Some represented the ion as having a single negative charge. Most were able to correctly show the eight outer shell electrons, although some very weak candidates gave the atomic, rather than ionic, structure, hence showing only six electrons.

Question 7

The question asked candidates to 'use the information to *explain*' the need for both processes. Hence, answers which merely quoted values, for example *'in process 1, 32% of ethene is made, and in process 2, 20% of ethene is made*' did not gain credit. Candidates needed to show that they understood that the output of ethene is *higher* in process 1, and that similarly the output of C_5 to C_8 is *higher* in process 2.

Section B

Question 8

This was a new type of question which relied on the ability of candidates to handle new, unfamiliar data and to apply their existing knowledge to explain the patterns that the data shows. This proved difficult for many candidates for several reasons. A surprisingly common error was to read the graph 'backwards' from right to left, starting at 0. Hence, in part **(a)** many candidates discussed the *increase* in carbon dioxide over time, and the *decrease* of oxygen. Another common difficulty was in planning out the necessary number of points for such a large mark allocation. Weaker candidates did not make enough points to access all of the marks. These issues meant that even more able candidates commonly scored around eight of the ten available marks.

(a) The commonest reason for failing to score was when candidates did not read the graph scale properly, giving the answer '1 000 years' rather than the correct '1 000 *million* years'. Almost all candidates knew that gas 3 was nitrogen, although a few gave 'methane' or 'hydrogen'.

(b)(i) This question tested the candidate's ability to relate the shape of a graph to the change in a variable (in this case percentage of carbon dioxide and oxygen). Weaker candidates described the graph *shape* rather than the *change in the percentages of gases*, for example by stating:

'For carbon dioxide, the percentage goes down, goes down steeper and then levels out.'

Such answers only gained partial credit.

More able candidates correctly linked gradient to rate, for example by stating:

'The percentage of carbon dioxide falls, then falls at a faster rate, and then remains constant'.

(ii) Most candidates knew that photosynthesis produces oxygen and uses carbon dioxide and that respiration is responsible for the reverse change. Better answers linked this knowledge to the data by identifying how these processes affected the percentage of the two gases in the atmosphere as plants and then animal life evolved. Fewer stated the two necessary equations. It was unclear whether this was because candidates did not know the equations or whether there was a lack of care over ensuring that each part of the question was fully answered. Where the equations were attempted, they were not usually correct, common errors being incorrect formulae for glucose and incorrect balancing.

(c) Candidates were told that that the process of extracting oxygen from air was fractional distillation, but few could explain how this process is carried out. Many suggested heating air. The best answers correctly explained that the air is liquefied (technical details, though not demanded were often given) and then warmed.

Question 9

As with **B8**, this question relied on the ability of candidates to structure their responses to gain a comparatively large number of marks. This limited the scoring for some candidates.

(a) Marks were awarded for identifying the pairs of important reagents, giving observations and equations and linking ability to displace to reactivity. Some candidates left out some of these aspects, despite the question clearly stating that they were necessary. Although candidates were not penalised for their presentation of the information, Examiners commented on the lack of structure shown in the answers, with some candidates giving large volumes of information, some of which was contradictory, making it difficult to clearly see whether full understanding was shown. Again, this implies that more planning of ***Section B*** answers is needed.

There were more marking points in the mark scheme than marks available, so more able candidates easily scored the maximum for this question. Common errors included:

- Wrong observations, for example the production of the halogens as gases or solids rather than as coloured aqueous solutions.
- Incorrectly balanced equations, or equations with wrong formulae. The same error was often repeated in every equation given, leading to a potential loss of several marks.
- Confusing the order of reactivity, believing that iodine is the most reactive.

(b) This was generally well answered. Candidates clearly understand oxidation states well. There was some confusion evident between ionic charge and oxidation state, with some candidates discussing the oxidation state of 'Cl^{+}'. Candidates should note that it is important to always give the sign when giving an oxidation state, i.e. '+1' not '1' alone.

Question B10

(a) Most gained a mark for drawing a labelled diagram of a suitable electrolysis cell, however many omitted to draw a system for collecting the gases.

(b)(i) Candidates all knew the ions present, but some lost marks by writing incorrect ions such as SO_4^{-} and O^{2-}.

(ii) The half equations were usually correct, but too many candidates did not give the overall equation or the gas tests. The correct overall equation was very rarely seen, those who did attempt to write this often gave the equation backwards. The gas tests were easy marks. The usual common errors of testing hydrogen with a glowing splint and oxygen with a burning splint were seen.

(iii) Very few stated that the acid would increase in concentration. This was a good discriminator for the most able. Common answers included that only sulphate ions would be left in solution and that the acid would become more dilute.

(c) Most knew that sulphuric acid reacts with a reactive metal to produce hydrogen. However, marks were not given if the metal chosen would be too hazardous to attempt under normal laboratory conditions. Group 1 metals were not accepted. Best answers gave magnesium, zinc or iron.

Question B11

(a) The formula for iron oxide was given in the question, but some candidates used formulae for other oxides e.g. FeO, in their answers. However, many candidates succeeded in balancing this difficult equation, usually giving fully correct state symbols. Again, many omitted part of this question by failing to give any observations for the reaction.

(b) Most gained a mark for realising that magnesium is more reactive, but fewer gave any difference in the *observations* between the two experiments, which was what the question demanded. Most knew that copper is less reactive than iron, but few correctly stated that no reaction would occur

(c)(i) Candidates found this part surprisingly difficult. Most correctly stated that aluminium is less dense and more corrosion resistant than copper. Some discussed differences in conductivity and a common error was to discuss the relative ability of the two metals to *rust*.

(ii) The diagrams of metal structures were not well attempted. The commonest error was to draw the cations as circles without any positive charges. Most knew that a 'sea of electrons' was involved but commonly drew either many more electrons than cations, or drew the cations in a central group with the electrons clustered around the outside. Electrical conductivity resulting from moving electrons was known by all.

Paper 5070/03

Paper 3 – Practical Test

General comments

The overall standard was high and candidates are to be congratulated on the way they tackled the examination. Only a few candidates were unable to demonstrate significant practical skills.

Comments on specific questions

Question 1

(a) Candidates were required to identify the acid present in solution **P**, by carrying out a number of simple tests.

Test 1

When a mixture of **P**, aqueous sodium hydroxide and aluminium is heated, vigorous effervescence takes place. The gas in this case is hydrogen and therefore 'pops' with a lighted splint. Although many candidates noticed the effervescence (bubbling), relatively few correctly identified the gas. Many thought it was ammonia and a surprisingly large number identified chlorine. In both cases, candidates had tried to identify the gas 'theoretically' rather than 'practically'. Ammonia is the 'expected' gas and those candidates who failed to detect hydrogen but who commented that 'the gas was not ammonia' gained some credit. A surprising number noted the effervescence and then stated 'no gas produced', presumably having failed to detect ammonia they had not tested for any other gas. In all cases where a gas is produced, candidates are expected to report the observation, effervescence etc. and then to test and name the gas. A disappointing number still fail to make all three points and lose marks unnecessarily.

Tests 2 and 3

With barium nitrate there is no precipitate, but silver nitrate produces a white precipitate confirming that **P** contains hydrochloric acid.

(b) The titration was well done most candidates scored full, or nearly full marks. Full marks were awarded for recording two results within 0.2 cm^3 of the Supervisor's value and then for averaging two or more results which did not differ by more than 0.2 cm^3.

Teachers are asked to continue to emphasise that in any titration exercise, candidates should repeat the titration as many times as necessary, until they have obtained consistent results, and then to average these consistent results, having first 'ticked' them to indicate that these are their most accurate values. Although the majority of candidates do carry out this procedure carefully, a small number still tick only one result. Similarly a number of candidates average all their results, irrespective of how consistent they are. Deciding whether to disregard some results is an important skill, and teachers are asked to reinforce this message.

(c) Most candidates were able to calculate the correct concentration of the acid in **P**. There were very few examples of candidates inverting the volume ratio or using a mole ratio of anything other than 1:1. The answer was required to three significant figures and few candidates over approximated.

Question 2

This was a relatively straightforward exercise and many candidates scored high marks. Where marks were lost it was usually for incomplete rather than incorrect observations. Most candidates used the correct terminology to describe the formation of precipitates and their subsequent solubility. There is still some confusion between clear and colourless and a small number of candidates do not appear to know that the term precipitate only ever relates to a solid.

Test 1

(a) Aqueous sodium hydroxide was added to solutions of three metal salts. **S** (aluminium chloride), **T** (lead(II) nitrate) and **U** (silver nitrate). With both **S** and **T** a white ppt is formed. With **U** the precipitate is brown, shades of brown were allowed but not red/brown. Most candidates scored these marks, the only errors occurred when candidates either added too much sodium hydroxide and caused the precipitates with **S** and **T** to redissolve and so cause themselves problems later on, or to say that the precipitate dissolves on mixing. Good technique makes it easier for candidates to report their results after mixing.

(b) When excess aqueous sodium hydroxide is added to the precipitates formed in *Test 1*, **S** and **T** both produce colourless solutions when the precipitates dissolves. With **U** the precipitate does not dissolve. Most candidates made the correct observations, but many forgot to describe the final solution as colourless.

(c) With excess aqueous ammonia, the precipitates formed with **S** and **T** do not dissolve, but the precipitate formed with **U** does, again producing a colourless solution. This test proved more difficult than the one with excess sodium hydroxide.

Test 2

With hydrochloric acid, there is no reaction with **S**, but **U** and **T** both give white precipitates. Candidates generally scored all three marks for this test.

Test 3

The addition of aqueous potassium iodide produces no reaction with **S**, a yellow precipitate with **T** and a pale yellow precipitate with **U**. The colour of silver iodide is difficult to describe and a range of shades were acceptable provided the colour was 'less yellow' than lead iodide and 'more yellow' than white. The precipitate is not green but yellow/green was allowed. Most candidates made all the relevant observations.

Conclusions

Most candidates identified the metal ion in **T** as lead, **S** proved more difficult, as many candidates thought the metal hydroxide precipitate dissolved in excess ammonia and therefore identified it as zinc rather than aluminium. Very few candidates identified **U** as silver, most who gave an answer thought it was iron(III). Although the question asked for formulae, names were accepted.

Paper 5070/04
Alternative to Practical

General comments

This paper is designed to test the candidate's knowledge and experience of practical chemistry.

Skills including recognition and calibration of chemical apparatus and their uses, recall of experimental procedures, handling and interpretation of data, drawing and interpretation of graphs, analysis of unknown salts and calculations will be tested.

The standard continues to be maintained and the majority of candidates show evidence of possessing many of the aforementioned skills.

Most candidates show competency of plotting points accurately on graphs and drawing appropriate lines through the points.

Calculations are generally completed accurately using the appropriate significant figures.

The subject on which **Question 2** was set, that of the reactivity series and metal displacement, was not generally well understood. Many candidates were not able to suggest the nature of the two unknown metals M and N given the results of the two experiments involving these two metals. Similarly answers to **Question 9 (d)** frequently showed a similar lack of knowledge.

Comments on specific questions

Question 1

This question involved the reaction between calcium carbonate and hydrochloric acid. Candidates were asked to comment on the rate of the reaction and to suggest ways to increase the rate.

(a)(b) The volume of carbon dioxide in the syringe was 46 cm^3. The volume of gas collected would be the greatest during the first minute. Acceptable reasons for this, as suggested by the candidates, included that the concentrations of the reactants decreased as the reaction proceeded and the rate of the reaction is always the greatest at the beginning.

(c)(i) The number of moles of calcium carbonate used in the experiment was 0.005.

(ii) A correct answer to **(i)** gave 100 cm^3 of 0.10 mol/dm^3 hydrochloric acid required to react with this amount of calcium carbonate.

(iii) The reaction would then produce 120 cm^3 of carbon dioxide.

As with all calculations, candidates who calculate an answer incorrectly may use this incorrect answer correctly in subsequent parts and gain any available marks.

(d) The rate of this reaction may be increased by **(i)** powdering the calcium carbonate and **(ii)** increasing the concentration of hydrochloric acid.

Question 2

This question was designed to test the candidate's knowledge and understanding of the reactivity series and metal displacement.

(a) Hydrogen was produced in the tube containing magnesium in contact with sulphuric acid. This should be tested in the usual way by the introduction of a flame to produce a 'pop'. The statement 'burns with a pop' is not acceptable. M could be any metal below hydrogen in the reactivity series, popular choices being silver, gold, platinum and mercury. Alternative acceptable reasons included no reaction with dilute sulphuric acid.

(b) Many candidates found this part of the question to be the most difficult. A deposit was seen in tubes III, IV, and V. Metal N is situated between magnesium and copper in the series and could be, for example, zinc or iron. Aluminium, as suggested by some candidates, is incorrect as N is shown to be N^{2+}.

(c) The reaction between iron(III) oxide and carbon produces carbon dioxide, as tested by limewater turning 'milky'. A balanced equation scores two marks. An equation showing all the reactants and products but not balanced scores one only. Answers to **(i)**, giving carbon monoxide as the gas could score all the marks, and equations showing iron(II) oxide as the product could score both equation marks.

Questions 3-6

The correct answers are (c), (b), (b) and (c) respectively.

Question 7

This was a standard titration question and was well answered by the majority of candidates.

2.05 g of $B(OH)_2$ was weighed out. Methyl Orange indicator was used, acceptable colour changes being yellow to pink or red.

Most candidates read the burette diagrams correctly and deduced the correct mean value to be used in the calculations. In cases where incorrect titres are produced, candidates should take the closest two volumes to calculate their mean value, not necessarily the second and third titres.

The correct mean titre of 25.3 cm^3 gave the following answers to the calculations:

(d) 0.0024 moles, **(e)** 0.0012 moles, **(f)** 0.012 moles, **(g)** 170.8 and **(h)** 137.

Two marks were awarded for a correct answer to **(h)(i)**, the first of which was for the recognition that 34 (2 x OH) should be subtracted from the answer to **(g)**. The need for the candidate to suggest the identity of the element, **B** in **(h)(ii)** was removed from the question, as it was accepted that an error was made in the expectation that candidates had access to a periodic table.

Question 8

This was a standard analysis question. The correct answers were:

(1) Dissolving **V** in dilute nitric acid produced a coloured solution. The word solution was essential to the answer. Descriptions such as substances, solids or precipitates lost the mark. Effervescence (1 mark) should be noted together with the testing of the gas with limewater (1) to confirm the presence of carbon dioxide (1). The last mark was only awarded if a test, to confirm its presence, was stated.

(2)(3) Tests both gave a green precipitate insoluble in the presence of excess of the reagent. Several candidates, who were not sure of the colour of the precipitate, suggested such colours as greenish brown or bluish green, neither of which was acceptable.

The formula for iron carbonate is $FeCO_3$.

Question 9

Candidates were asked to read diagrams of parts of thermometer stems to determine the maximum temperature reached in each part of the experiment. These temperatures were in general, correctly observed. The temperature rises were then determined for plotting on the grid. A common error was the calculation of the temperature rise from each previous temperature not from the initial 25°C. On plotting the temperature rises on the grid candidates were instructed to join the points by two intersecting straight lines. The intersection gave an answer to **(c)(ii)**, the mass of zinc required to completely react with 50 cm^3 of the copper sulphate solution, of 0.65 g. Candidates who connected the third and fourth points by a curve lost the third graph mark and were not able to obtain an answer to **(c)(ii)**.

Marks for answers to both parts of **(c)**, were awarded on the candidate's accurate reading of the graph to the nearest half a small square.

In **(c)(iii)** the temperature was the same in the last two experiments because either the reaction had finished or all the copper sulphate had been used or reacted. Answers stating that all the zinc had been used were incorrect as the zinc was stated to be in excess.

Answers to **(d)** included: zinc dissolves or reacts or disappears, copper or a red deposit or solid forms at the bottom of the beaker, the blue solution loses its colour or becomes colourless (not white) and effervesces or fizzes.

The final part **(e)** requires the calculation of the number of moles of zinc that had reacted with the copper sulphate solution, 0.01 moles (0.65/65) and then to deduce that 0.01 moles of iron is 0.56 g. An incorrect answer to **(c)(ii)**, such as 0.8 g, could be used consequently in **(e)** giving, in this case, an answer of 0.69 g of iron.