CHEMISTRY

Paper 5070/01
Multiple Choice

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

General comments

All questions all produced good discrimination with respect to the abilities of the candidates. Candidates found **Questions 34** and **40** to be the most straightforward.

Comments on Individual Questions

Question 2

This was really a question about relative rates of diffusion. Ammonia having a lower M_r than hydrogen chloride reached the litmus paper first and turned the litmus paper blue. Eventually the hydrogen chloride, which diffuses more slowly, reaches the litmus paper and turns the litmus red.

Question 8

Sodium chloride was the only ionic compound in the question and the answer to the question. All the other compounds were covalent compounds.

The answer relied on the knowledge that in general ionic compounds have high melting points and covalent compounds have low melting points.

Question 9

Graphite conducts electricity due to the movement of electrons and does not contain any ions, thus the very popular alternative D was incorrect.

Question 13

Alternatives A and C were popular distractors. When an element burns in oxygen it always combines with the oxygen and therefore the product has a mass equal to the original mass of the element plus the mass of the oxygen which has combined with the element.

Question 22

A solution of sulphuric acid contains a large number of hydrogen ions. Neutralisation of the acid involves reducing the number of hydrogen ions in the solution. The only reaction where the number of hydrogen ions is not reduced is in alternative B and here the hydrogen ions are spectator ions.

Question 23

Zinc carbonate is insoluble and should be prepared by a method involving precipitation. Thus the method involving the mixing of two solutions to form solid zinc carbonate was the most appropriate.

Question 31

The simplest ionic equation for these reactions is

$$NH_4^+ + OH^- \rightarrow NH_3 + H_2O.$$

Therefore the number of moles of NH_4^+ present in each alternative was the route to the answer and not how many moles of nitrogen were present.

Question 37

Equal volumes of gas, under the same conditions, contain the same number of molecules. So rather than considering volumes the candidates had to find an equation where one molecule of hydrocarbon produced seven molecules of gaseous products, since the simplest ratio of 10:70 is 1:7. Therefore C was the correct response.

CHEMISTRY

Paper 5070/02
Theory

General comments

Although this Paper contained several questions with unfamiliar context, many candidates tackled this paper well and coped with the information handling and problem solving aspects involved. Good answers were seen in questions 1, 2 and 4. Few candidates, however, scored full marks on the other questions, generally losing marks on those parts which required a degree of explanation and writing. The rubric was generally well interpreted. The majority of candidates attempted all parts of each question and most attempted three questions in part B. Most of the candidates who scored well on ***Section A*** continued to maintain this standard in ***Section B***. This is in contrast to previous sessions, where many who performed moderately in ***Section A*** failed to keep up the standard in ***Section B***. It is encouraging to note that in ***Section B*** many candidates did not give unnecessarily lengthy answers to questions involving free response e.g. **B7(a)**, **B8(e)**, **B10(e)**. Question **B9(e)**, however, did elicit some over-complicated responses. In extended questions, some candidates disadvantaged themselves by non-specific writing. Candidates should be reminded that although some of these questions involve free response, the Examiners are only looking for a few essential points and the number of marks can be used as a guide to the length of answer and the number of points required. Candidates would be advised to look at the detail put in the marking schemes to satisfy themselves of the amount of detail required. The standard of English was generally good.

Most candidates' knowledge of structure and properties in terms of atoms, ions and electrons was poor and this was reflected in their answers for parts of **A4** and **B10**. Many candidates were found to have an inadequate knowledge of practical procedures as shown by answers to questions **A5(a)** on chromatography and **B10 (e)** on measuring reaction rate. A considerable number of candidates had difficulty in writing symbol equations and many had difficulty in balancing the electrons in the electrolysis in **B9**. There were only a few instances where candidates disadvantaged themselves by giving contradictory answers and it is encouraging to note that many candidates performed reasonably well on the calculations and many less able candidates acquitted themselves well by calculating empirical formulae and percentage purity correctly.

Comments on specific questions

Section A

Question A1

Most candidates obtained at least four of the six marks available. **Parts (a)** and **(e)** were the parts most commonly answered incorrectly.

(a) Nitrogen was the most common incorrect answer. Presumably, the candidates think of 'natural' as meaning 'in the air'. The other incorrect answer, not infrequently seen was 'hydrogen'. Many candidates seem to think that hydrogen is present in the air – this idea was incorrectly reiterated in some answers to **question B9**.

(b) Most candidates correctly identified carbon dioxide. The most common incorrect answer was oxygen.

(c) The other nitrogen compounds (nitrogen gas or nitrogen dioxide) were occasionally incorrectly given in place of ammonia.

(d) Carbon monoxide was almost invariably chosen.

(e) Ammonia as the product of the Haber process was generally well known. The most common incorrect answers gave nitrogen or nitrogen dioxide.

(f) A range of incorrect answers was seen, the most common of which was oxygen.

Question A2

Most candidates understood something about the process of diffusion in terms of moving molecules and many scored well on this question. It is, however, unfortunate that many candidates still think of diffusion in terms of bulk flow. Diffusion is a random movement of molecules. Statements such as 'the molecules move from a high concentration to a low concentration' are not correct. It is the bulk flow of the substance that is in this direction. The molecules move in any direction just by chance, not by design.

(a) Most candidates identified ammonium chloride correctly. A minority of candidates wrote 'ammonia chloride' which was not acceptable. Weaker candidates gave answers such as nitrogen chloride, ammonia or hydrochloric acid.

(b) The link between the molar mass and diffusion was generally established although fewer mentioned the word 'diffusion' and many failed to write about 'particles' or 'molecules' moving which was implicit in the stem of the question. A good proportion of weaker candidates suggested incorrectly that the position of the ring was due to the difference in concentration of the ammonia and hydrochloric acid at the start.

(c) Candidates could obtain the marks here by comparing the rate of diffusion of methylamine with either ammonia or hydrogen chloride and there were many good answers. Many candidates, however, confused the issue by not making clear which molecules they were comparing or including all three. Again incorrect ideas about differences in concentrations were not uncommon. A minority of candidates answered this part using the incorrect assumption that the question was about rates of reaction.

Question A3

Although this question was reasonably well answered by many candidates, few scored very high marks. The qualitative analysis in **part (c)** was often poorly done and a variety of errors were seen in all the other parts.

(a) Many candidates gave the correct answer (4 electrons) but a considerable number thought there were six electrons in the outer shell. This was presumably a reading error through not focusing on the words 'outer shell' and merely giving the total number of electrons. A minority of candidates gave the incorrect answer '14 electrons'. This presumably arises as a consequence of adopting the 18 Group Periodic Table where the pattern of electrons from Group 3 onwards can no longer be related to the Group number.

(b) (i) Many candidates failed to gain the mark through giving specific formulae e.g. Ge_2H_6 or giving the general formula for various types of hydrocarbon.

(ii) This was, in general well answered, practically all candidates writing some sort of geometric formula. Common errors included writing the formula for ethane instead of germanoethane, putting a double bond between the Ge atoms and omitting one or more hydrogen atoms.

(iii) It was encouraging to note that even many weak candidates could balance the equation. Common errors included putting the formula of magnesium chloride as $MgCl$ and the lack of a 4 before the HCl.

(c) This was answered correctly by about half the candidates. Many thought incorrectly that amphoteric oxides were 'neither acidic nor basic' or that they were 'neutral'. There were also many incorrect statements about metals as compared with non metal oxides or statements relating to their reaction with oxygen.

(d) The use of sodium hydroxide and the resulting green precipitate were well known. Only a few candidates disadvantaged themselves by suggesting that an acid should be added as well as the hydroxide. A significant minority confused the result with that for iron(III) but fewer than usual gave the wrong test altogether – of these litmus was the most popular incorrect test reagent.

Question A4

Most candidates coped with the unfamiliar context well but some confused the structure of the nanotubes with that of graphite and talked about layers of atoms. The nature of the covalent bond was not well understood, many candidates confusing it up with an ionic bond – this was especially elicited by the answers to **part (b)**. **Part (c) (ii)** showed up the perennial difficulties that candidates have with understanding electrical conduction.

(a) Many candidates could correctly recognise at least one difference between the nanotube and diamond structures. Many failed, however, to describe theses differences accurately or only described one structure and hence gave no comparison. Candidates should be advised to look out for the word ‘differences’ and in such cases write their answers as ‘the X ….. whereas the Y…….’. Common vague statements abounded such as ‘nanotubes horizontal and diamond vertical’. Such statements show that the candidate does not understand the complete structure of diamond as going on (nearly) indefinitely in 3 dimensions.

(b) There were a lot of confused answers here and many candidates did not refer to the bonds but gave vague statements such as ‘the structure is strong’. Many candidates disadvantaged themselves by making contradictory statements such as there are strong electrovalent bonds or ionic bonds or that there are strong intermolecular forces. The latter is partly a result of the convention of calling structures such as diamond ‘giant molecular structures’.

(c)(i) Most candidates recognised graphite as the electrical conductor.

(ii) Many candidates did not access the essential point that the electrons are <u>moving</u> during electrical conduction. Many candidates failed to gain the mark because they wrote about moving ions (sometimes together with moving electrons).

(d)(i) This was generally answered well although many candidates failed to gain the mark because they did not refer to the electrons, merely stating that the ‘atom was stable’ or ‘it was a noble gas structure’. These answers are too close to what is asked in the stem of the question.

(ii) Most candidates scored the mark here, the most common incorrect answer being 18, the proton number of argon. Correct answer = 20

(e) The properties of transition metals were well known. Common errors included stating that the metals themselves are coloured, that they have low densities, and giving general metallic properties.

Question A5

Many candidates found this question demanding. Although the name of the technique in **part (a)** and the calculation in **part (c) (iii)** were correctly answered by most candidates, many could not describe the apparatus for chromatography or had some difficulty with the calculation in **part (c) (ii)**.

(a) Chromatography was generally correctly identified. Distillation and filtration were the most common incorrect answers. Many candidates obviously knew about chromatography but omitted crucial detail in the diagram that would enable it to work. Many candidates left the paper out of the solvent or had the solvent level above the spot of coloured solution. A large number of candidates failed to show a container. A significant minority failed to gain the marks because they placed the coloured solution where the solvent should have been.

(b) (i) Many candidates merely wrote down a type of simplified structural formula e.g. $(COOH)_2(CHOH)_2$ rather than the simplest possible formula. Surprisingly few candidates were able to work out the simplest possible formula, answers such as CH_3O_3 being quite common.

(ii) This calculation proved quite difficult for many candidates although many were able to gain at least one mark. Whereas the moles of KOH used was often calculated correctly, the division by 2 to get the moles of tartaric acid was often omitted. Many candidates relied on some sort of formula for calculating the concentration of the tartaric acid e.g. $MaVa/n_a = MbVb/n_b$. Candidates who did this often substituted the figures incorrectly and gave incorrect answers. Those who did the calculation in a stepwise logical fashion were far more likely to gain at least 2 of the three marks available. (answer = 0.015 mol/ dm^3)

(iii) Most candidates were able to perform this calculation correctly. A common error was to calculate the percentage impurity (7.5%) rather than the percentage purity (92.5%).

Question A6

Few candidates scored more than two thirds of the marks available for this question. Although most recognised acid rain as a pollutant, few could give a test for an oxidizing agent. The test for sulphate ions was less well known than the test for iron(II) ions earlier on in the paper, although it presents no greater difficulties. Few candidates could write a correct balanced equation for the decomposition of potassium nitrate.

(a) Although most candidates could write the correct formulae for potassium nitrate and oxygen, the main error was to fail to balance the equation. Potassium nitrate was occasionally written incorrectly with 4 oxygen atoms and oxygen written as an isolated atom was not uncommonly seen.

(b) The mark was gained by most candidates, the most common correct answer referring to acid rain in some way. The very few who failed to gain the mark usually referred to global warming or effect on the ozone layer.

(c) Most candidates scored at least one mark, usually for realising that the rate of reaction would be faster. Those candidates who realised that the surface area was greater with smaller lumps usually obtained both marks. Some candidates gave too vague answers to merit a mark e.g. 'the rate of reaction is affected by the size of the particles'.

(d) The test for sulphate was less well known than the test for iron(II) mentioned earlier in the Paper. Fewer candidates than expected gave a correct soluble barium (or lead) salt for the sulphate test. A few negated the whole point of the test by suggested barium sulphate as a reagent, while yet others suggested that the acid (used for digestion of any solid) should be sulphuric acid. Common incorrect reagents suggested were sodium hydroxide and silver nitrate. The colour of the precipitate was better known, yellow being the most common incorrect colour suggested.

(e) (i) Few candidates knew a suitable test for an oxidising agent. Those candidates who put potassium iodide often got the colour change correct although quite a few gave the reverse colour change. The most common error was to suggest an oxidising agent such as potassium dichromate or potassium manganate(VI). This may have been due to misunderstanding of the question which asked for a test for an oxidising reagent not an oxidising agent itself. A considerable minority of candidates incorrectly suggested that bromine be used (although potassium bromide would have been acceptable).

(ii) Most candidates made a sensible attempt in referring back to the equation and thus gained the mark. Those who went down the route of quoting oxidation numbers only, often failed to give the correct oxidation numbers. The syllabus does not require oxidation numbers to be calculated – it is sufficient to say that the oxidation number of a specific atom goes down in reduction. A number of candidates failed to gain the mark because of incorrect statements such as 'the oxygen in the chlorate is reduced'. A not inconsiderable number of candidates thought incorrectly that the electrons appearing on the left of the equation meant that they were being removed.

Question B7

Of the **part B** questions, this proved to be the most popular and often provided the candidates with at least half the marks available. The calculation was fairly well attempted and many weaker candidates gained at least two of the marks available even if they failed to score many elsewhere in the question. Most candidates had some knowledge of the processes involved in a catalytic converter.

(a) The marks for changing nitrogen oxides into nitrogen and carbon monoxide into carbon dioxide were often obtained but fewer candidates gained the mark for realising that the carbon monoxide reacted with the nitrogen dioxide. Those candidates who wrote a single equation for the reaction were most likely to get all three marks. Some candidates gave vague answers and unnecessary detail about the structure of the converter which was not required by the question. Quite a few considered the reactions in isolation and suggested that the nitrogen oxides decomposed into oxygen and nitrogen. Weaker candidates often suggested incorrectly, that both reactions were oxidations and that nitrogen oxides were oxidised to nitrates or to NO_3 gas.

(b) Where correct combustion products of heptane were given, the most common error usually involved incorrect balancing of the equation with 10 or 12 oxygen molecules often being seen. It was disappointing that many of the weaker to middling candidates appeared not to know the combustion products of a hydrocarbon.

(c) The calculation was well attempted but a considerable minority inverted the fractions in order to calculate the number of moles or rounded up the number of moles to one significant figure. This often led to the incorrect empirical formula. A number of candidates, through carelessness, failed to give the correct symbols for nickel when writing the final formula, N being a common error, and the replacement of oxygen by hydrogen was not uncommon. (correct answer NiC_4O_4)

(d) (i) Most candidates gave a suitable definition of a catalyst but comparatively few could define 'unsaturated'. The most common incorrect answers related to solubility, the candidates not taking into account the context of the question. Some candidates wrote vaguely about fats and made statements about the solubility of fats in water.

(ii) Many candidates lost the mark here because they wrote down the name of what they though an alternative catalyst should be i.e. platinum rather than the reactant hydrogen. Many candidates gave the conditions used rather than the correct reactant.

Question B8

Although this was a fairly popular question, few candidates scored well. Most made a good effort at the calculation and most could define a weak acid but there were many weak answers in part **(d)** and very few candidates achieved the mark for the equation in part **(b)**.

(a) Most candidates gave a good definition of a weak acid. The most common errors were to **(i)** suggest that weak acids only contain a few hydrogen ions (without any reference to concentration) **(ii)** state that weak acids have a higher pH (again without reference to concentration) **(iii)** write about the difference in rate of reactivity of weak and strong acids with metals.

(b) Very few candidates could balance the equation. The most common error was to give the formula of sodium carbonate as $NaCO_3$. Of those who wrote the formula for each species correctly, a considerable number failed to put a 2 in front of the propanoic acid even though they had put a 2 in front of the sodium propanoate. Other errors, commonly seen were to make write the formula of sodium propanoate $(C_2H_5COO)_2Na$ and to suggest that hydrogen is formed as a product (presumably thinking of the reaction between the acid and a metal).

(c)(i) Many candidates could extract the correct molar masses for the magnesium and propanoic acid or calculate the moles of magnesium correctly. Few candidates, however, calculated moles of both propanoic acid and magnesium or gave some indication of a mole calculation involving both. Although some realised that a 1:2 ratio was involved many failed to express this clearly as part of a calculation and many merely suggested that the propanoic acid was in excess because there were two moles of this in the equation and only one mole of magnesium.

(ii) Most candidates were able to score at least one mark for realising (with the correct mathematics) that the moles of hydrogen had to be multiplied by 24. Some candidates failed to gain the mark because they failed to put a unit or gave an incorrect unit. (correct answer = 4.8 dm^3)

(d)(i) Surprisingly few candidates identified the carboxylic acid and alcohol functional groups correctly. The most common error was to state the name of only one of them, usually the carboxylic acid. Many candidates failed to read the stem of the question properly and gave the incorrect answer 'ester' which refers to the group in the polymer rather than the functional groups present in the monomers. Another common error was to suggest 'amines'. This presumably arises from thinking of nylon but without looking for the nitrogen in the formula given in the question.

(ii) Many candidates realised that condensation polymerisation was involved but a considerable minority thought incorrectly, that the monomers were polymerised by an addition reaction.

(iii) Few candidates realised that *Terylene* was used to make clothes. There was a wide range of incorrect answers, the most common being 'to make nylon' and 'to make plastic bags'. A not inconsiderable number of candidates confused polyesters with simple esters and suggested that *Terylene* could be used as a flavouring.

(e) Many candidates had difficulty in linking the method of disposal with the problem. Many mentioned that plastics were thrown away but failed to mention lack of biodegradation. Many answers were far too vague or confused e.g. 'plastics are burnt because they are non-biodegradable'.

Question B9

Most candidates found this question quite demanding and high scores were rare. The equations were rarely correct and the idea of the electron flow from more reactive to less reactive metal in **part (e)** was rarely seen.

(a) Many candidates gained one of the marks for an advantage of hydrogen but few gained both marks. The most common incorrect answer related to the price of hydrogen. It was worrying to see that many candidates think that hydrogen is present in the air.

(b) The most common correct answer was explosive or highly flammable. Many candidates, however, seem to think that hydrogen will run out if we use too much of it. Many candidates suggested that hydrogen is expensive but without giving a reason or giving an incorrect reason.

(c)(i) Very few candidates appreciated that oxidation was taking place and a variety of incorrect answers was seen including 'exothermic' and 'neutralisation'. Many suggested a redox reaction. In this case, however, there is no reduction because it is a half equation. A considerable number of candidates suggested incorrectly either that hydrogen was being added to oxygen and so the reaction was reduction or the oxidation number of oxygen was increasing.

(ii) Few candidates used the information from the question to construct the ionic equation. Many reversed the products and the reactants. Relatively few candidates managed to balance the equation with the correct number of electrons.

(d)(i) More candidates wrote the correct equation in this part but many left electrons or other species on one or other side of the equation. A common error was to leave the equation unbalanced.

(ii) A wide range of electrolytes was given. Although many candidates responded correctly with hydrochloric or sulphuric acid, many failed to read the question properly and put either sodium hydroxide or sodium chloride.

(e)(i) Many candidates wrote far too much and often not to the point. Few candidates related the reactivity of magnesium and copper to the direction of electron flow. There were many vague and contradictory statements about anodes and cathodes, ions moving in solution and the process was often muddled with electrolysis. Candidates should be advised not to write too much especially if only two marks are available.

(ii) Candidates did not appreciate that magnesium and copper are above silver in the reactivity series and hence react with soluble silver compounds. The most common incorrect statements were that silver (that is, the metal rather than the compound) would not react and silver nitrate is a poor electrical conductor.

Question B10

This question was the least frequently answered of the four part B questions and candidates found it challenging. Although some candidates coped reasonably well with the description of the differences between the silicate and soda lime glass, many failed to make a proper comparison. Candidates did not score as highly as expected in parts **(c)** and **(e)** which were relatively straightforward standard questions.

(a) Although there were many partly correct responses, most candidates just plucked out particular features of a given structure and did not make a true comparison e.g. 'silicate has a regular structure and soda lime glass has ions'. Few candidates could correctly describe the structure of soda lime glass in terms of ions. Many candidates implied that it was a totally ionic structure or had sodium and calcium atoms. Many candidates wrote at length but the best answers came from candidates who gave simple answers such as 'the silicate is regular in structure and the soda lime glass irregular'.

(b) Fewer candidates than expected gained the mark for 'moving ions'. Most candidates thought that the electrons moved, despite the fact that ions were clearly shown in the diagram. Many candidates who realised that ions were responsible failed to mention that the current was due to the movement of these particles.

(c) A surprising number of incorrect equations were seen. Calcium rather than calcium oxide was often deemed incorrectly to be a product of the decomposition and many candidates muddled decomposition with oxidation and so put oxygen on the left hand side of the equation. The states of the species in the equation were not always well known, calcium carbonate and calcium oxide often being shown incorrectly as aqueous solution.

(d)(i) Few candidates realised that the hydroxide ion was responsible for alkalinity. A whole range of incorrect answers were seen with lead (taken from the stem of the question) predominating.

(ii) Since few candidates understood that the hydroxide ion is responsible for alkalinity, many could not give satisfactory answers to this part of the question. Few candidates gave a correct balanced equation, the most common errors being **(i)** to omit the 2 in front of the hydroxide and **(ii)** to suggest that lead oxide was a product. Few candidates appreciated that the whitening was due to lead hydroxide and wrote incorrect statements such as the 'lead precipitates' or 'the water reacts with the lead to form a white colour'.

(e) The practical procedure for measuring the rate of reaction involving the release of a gas was reasonably well known but written descriptions were often not sufficiently precise. Many candidates drew good diagrams of the apparatus but those who tried to describe the apparatus without a diagram were usually not able to do justice to their case. Students should be advised that a good labelled diagram often scored better than a lengthy description. Some diagrams suffered from the fact that the system was not closed (usually due to lack of a stopper in the flask). Many candidates were vague about the measurement of volume and time. Just writing that 'you use a clock to time the reaction' or 'find out how long it takes for the reaction to finish' are far too vague to be awarded a mark. In order to gain the marks the candidates had to specify that both the time and volume or mass had to be at least measured at the beginning of the reaction and at some other specific time. The best answers were in the form 'measure the volume of gas at particular times throughout the experiment'. A significant number of candidates did not understand what was required and merely wrote about measuring the temperature rise of the reaction. Some candidates wrote about counting the number of bubbles. While this may give some sort of rate for a slow reaction, this is not a slow reaction and this method can not be regarded as being quantitative enough to gain full marks for this question.

CHEMISTRY

Paper 5070/03

Practical Test

General comments

The overall standard was very variable and although many candidates were able to demonstrate significant practical skills a significant minority appeared to have had very little experience of the type of exercises they were required to do.

Comments on specific questions

Question 1

(a) The hydrochloric acid/ sodium hydroxide titration was generally well done. Many 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.

Teacher 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.

(b) Most candidates were able to calculate the correct concentration of the hydrochloric acid in **P**, although there were a few examples of candidates inverting the volume ratio or using a mole ratio of 1:2. Answers were required to three significant figures and there were only a few examples of candidates over-approximating.

(c) Candidates didn't perform as well on this part as had been expected. The mixture of **P** and **R** effervesces slightly and the gas will turn lime-water milky proving that it is carbon dioxide and hence identifying **R** as zinc carbonate. Candidates tended to either make all these points or none.

Question 2

This was a difficult exercise with many colour changes and marks were somewhat disappointing. Marks were usually lost for failing to describe the changes sufficiently accurately. Most candidates used the correct terminology to describe the formation of precipitates although 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. In reactions in which a gas is produced, candidates are expected to give the test for the gas and then name it. A surprising number lose marks unnecessarily by omitting one of these statements. It was not necessary to make all the observations to score the full 19 marks.

Test 1 When **S**, the copper(II) ammonia complex ion, is heated a number of changes take place. The easiest of these is that the gas turns litmus blue and is therefore identified as ammonia. This observation was not made as widely as had been expected. The solution also produces a blue precipitate which then turns black. A range of colour changes was acceptable

Test 2 The addition of hydrochloric acid to **S** produces a pale blue precipitate of copper(II) hydroxide which dissolves in excess to give a pale blue solution. Candidates who described the precipitate as white and the final solution as colourless scored some marks. If the acid is added too quickly the dark blue solutions turns to a pale blue solution without ever producing a precipitate. This was a common error.

Test 3 The addition of aqueous barium nitrate to **S**, gives a white precipitate in a dark blue solution. Allowing the mixture to stand makes it easier to distinguish between the colour of the precipitate and the colour of the solution. A number of candidates described the precipitate as blue and this gained some credit. When nitric acid is now added, the precipitate does not dissolve, but the solution becomes much paler in colour. The second of this observation was reported by only a minority of candidates.

Test 4 This is a complex test with many colour changes and although most candidates made a number of observations only a small number reported them all. There is no initial reaction with potassium iodide. Candidates must not be frightened of simply putting 'no reaction'. When hydrochloric acid is then added the redox reaction between Cu^{2+} and I^- now takes place. When the reaction mixture is allowed to stand, a pale precipitate can be seen in a brown solution. A reasonable range of colours was allowed for both the precipitate and the solution. The initial reaction of sodium thiosulphate is to decolourise the brown solution and allow the colour of the precipitate to be seen as white. With excess sodium thiosulphate the precipitate dissolves to form a colourless solution. On standing a new white or pale yellow precipitate appears.

Conclusion

The production of a white precipitate in **Test 3** suggests that the SO_4^{2-} ion is present and the ammonia formed in **Test 1** suggests the NH_4^+ ion is present. Most candidates correctly deduced that Cu^{2+} was also present.

CHEMISTRY

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

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 joining the points as instructed.

Calculations are generally completed accurately using the appropriate significant figures.

Question 1

Candidates are asked to recognise instrument B, a pipette, as best used to measure out accurately a fixed amount of liquid.

Question 2

(a) This question involves the laboratory preparation of ethene gas. Candidates are asked to insert, in the boxes on the diagram the appropriate reagents. These could either be ethanol with aluminium oxide or a hydrocarbon oil or long chain hydrocarbon with porcelain etc. This proved to be difficult for the majority of candidates although correct answers to some or all of the remaining parts of the question were generally seen.

(b) Ethene is insoluble in water, as indicated by the method of collection.

(c) The delivery tube is removed from the water to prevent water 'sucking' back into the connecting tube.

(d) A common error here is to use gaseous bromine to test for ethene not aqueous or bromine water.

Question 3

This question involves Chromatography.

(b) The lines on the diagram show the start and finish lines of the solvent.

(c) The use of an ink pen to draw the start line is unsuitable as ink contains a number of different dyes or substances which separate to produce extra dots or lines on the chromatogram. An answer suggesting that the ink interferes with the other spots is not specific enough.

Answers to **(d)** were generally correct as was **(e)(i)**, the definition of R_f value.

In **(e)(ii)** candidates are required to show the evidence used to conclude that **P** has an R_f value of 0.45. An answer of **P** on its own would not gain the mark.

Question 4

(a) Barium sulphate appears as a white precipitate or solid.

(b) The number of moles of sulphuric acid and barium nitrate are 0.015 and 0.02 respectively.

(c) Candidates should realise that the lesser of the two is the limiting reactant, giving a mass of barium sulphate of 3.50 g. (0.015 × 233) g.

(d) Assuming a correct answer to **(c)** the percentage yield is 95.7%.
Candidates who use the wrong reactant moles or calculate one or both of the number of moles incorrectly are able to score marks if the subsequent calculations are correct.

(e) The increased mass of product may have been due to the product being damp.

(f) Alternatives to barium nitrate are barium chloride or carbonate.
Barium hydroxide is not acceptable as it is not a salt.

Question 10

(a) 4.85 g of the mixture is weighed out. Copper(II) oxide reacts with sulfuric acid, leaving the copper as a deposit in the solution. This is removed by filtration, **(b)(ii)**, to leave a blue solution **(b)(i)**.
Most candidates were able to write a correct equation. Common errors include an incorrect formula of copper(II) oxide e.g. Cu_2O, and an equation involving the evolution of hydrogen.

(c) The blue solution in the flask turns green at the end-point.

(d) The titration volumes were 26.6, 26.1 and 26.3 cm^3 giving a mean volume of 26.2 cm^3 to be used in subsequent calculations. A common error is reading the burette diagram calibrations from the bottom, rather than from the top.

(k) The answer to **(j)** utilises the mole ratio of CuO to H_2SO_4 as shown in the equation in part **(b)(iii)**.
Any incorrect equation in **(b) (iii)** was considered in assessing the answers to **(j)** and **(k)**.
Candidates should be encouraged to attempt all parts of a question, particularly calculations, even if they are uncertain of their answers to earlier parts.
Candidates are advised not to approximate answers as marks may be lost. The appropriate significant figures should always be maintained.

Question 11

(a) The coloured solution suggests that a transition metal ion is present in V. An answer stating that V is a transition metal was not accepted.
This question was generally well answered by most candidates.

Question 12

Candidates are asked to plot the rises in temperature on the grid and connect the points by two intersecting straight lines. The intersection gives the maximum temperature which occurs using these two solutions. A large number of candidates connected the points with three straight lines following the points which had been plotted. This gives the highest temperature as 9.0° not the correct rise of 9.8°.

The volumes of H and J, corresponding to 9.8°, are 56 and 44 cm^3. Candidates can read their own maximum from their graph and their corresponding volumes of **H** and **J** to score full marks.

(e) Using the ratio of moles of **H**, H_2SO_4 to J, NaOH of 1:2 the concentration of **H** may be calculated. Volumes of **H** and **J** of 56 and 44 cm^3, gives the concentration of **H** to be 0.39 moles/dm^3.

(f) The correct answer is half the temperature rise noted in **(c)(i)**. The volumes of **H** and **J** are the same as in **(c)(i)**.

In the plotting of points and reading of graphs candidates are expected to be accurate to the nearest half small square.