

CHEMISTRY

Paper 5070/01 Multiple Choice
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<i>Question Number</i>	<i>Key</i>	<i>Question Number</i>	<i>Key</i>
1	D	21	D
2	B	22	D
3	A	23	D
4	B	24	D
5	B	25	A
6	A	26	C
7	B	27	C
8	C	28	D
9	D	29	D
10	C	30	C
11	D	31	C
12	C	32	D
13	D	33	C
14	D	34	C
15	A	35	D
16	B	36	B
17	B	37	B
18	C	38	B
19	D	39	A
20	C	40	A

General Comments

A number of questions were very much to the candidates liking, in particular questions **8, 18, 22, 28, 31, 37, 39** and **40** which were successfully answered by the majority of the candidates. Unfortunately, **question 1** failed to achieve any of the criteria expected of a question on this paper.

Almost all the remaining questions discriminated well between the candidates.

Comments on Individual Questions

Question 1

The oxygen gas was collected by the displacement of water and was always going to be contaminated with water. Prior to the addition of hydrogen peroxide the apparatus was full of air which is approximately 80% nitrogen. Taking into account these two factors it was hoped that the candidates would give **D** as their answer and not **A**.

Question 5

The appreciation of the word molecular in the stem of the question was the key to the correct answer. Thus the second most popular answer, the ionic compound sodium chloride, (option **C**), was incorrect.

Question 6

This question was intended to test the idea that when covalent liquids boil the molecules themselves are not decomposed, and it is the strength of their intermolecular forces which determines their boiling point.

Question 10

Guessing was widespread in this question. Lead sulphate is insoluble and should therefore be prepared by mixing two compounds in solution. Thus alternative **C** was correct because these two reagents were the only soluble pair of compounds.

Question 17

An increase in pressure, alternative **C**, would increase the rate of reaction but not the equilibrium concentration of hydrogen iodide. As so often, the candidates confused the effect on the rate of reaction with the effect on the equilibrium.

Question 24

Carbon monoxide does produce carbon dioxide on burning and consequently this alternative was a frequently given incorrect answer. Once again, careful reading of the question and the realisation of the importance of each word in the stem were vital to obtaining the correct answer.

Question 38

Options **B** and **D** were almost equally popular because four hydrogen atoms were needed to saturate the compound. The split in the answers was probably due to many candidates missing the significance of the word molecule in the stem of the question.

CHEMISTRY

Paper 5070/02 Theory

General comments

Many candidates tackled this paper well, especially **Section A**. Aspects of inorganic Chemistry were generally well answered but, as in previous years, questions involving organic reactions tended to create problems for many candidates. Good answers were seen for **Questions A1, A2 and A3**. Few candidates, however, scored full marks on the other questions, generally losing marks on those parts which required a degree of explanation, e.g. **B8(b)** and **B9(b)(iii)**. The rubric was generally well interpreted. The majority of candidates attempted all parts of each question and few attempted four questions in **part B**. Most of the candidates who scored high marks for **Section A** continued to maintain this standard in **Section B**. However, many who scored around 25 – 30 marks in **section A** failed to keep up the standard in **Section B**. In **Section B**, many candidates gave unnecessarily lengthy answers to some of the questions involving free response, e.g. **Questions B7(c), B7(d)** and **B10(a)**. Candidates should be encouraged to write concisely, using bullet points if necessary. In some **Section B** questions, some candidates disadvantaged themselves by inaccurate and 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 these is specified by the number of marks. As suggested in last year's report, candidates would be advised to look at the detail in the mark schemes to satisfy themselves of the amount of writing required. The standard of English was generally good. In **Section B**, all the questions appeared equally popular and there did not appear to be much difference in the facility with which each question was answered, although **Question B8** seemed to provide marginally fewer marks for candidates who selected it. Qualitative tests and general properties were reasonably well-known although the chemical and physical properties of a non-metal oxide, **Question A5(a)(ii)**, seemed to be lost on many. Most candidates' knowledge of structure and properties in terms of atoms, ions and electrons was poor and this was reflected in many confused answers for parts of **Questions A3** and **B10**. It is encouraging to note that many candidates were found to have an improved knowledge of practical procedures as evidenced by reasonably good attempts at **Questions B7(c)**. A considerable number of candidates had difficulty in writing symbol equations which were correctly balanced, and few were able to give the structure of poly(propene) in **Question B8**. There were only a few instances where candidates disadvantaged themselves by giving contradictory answers. These were most commonly seen in **Question B7(a)** where the definition of reduction in terms of addition of electrons to chlorine was sometimes negated by an incorrect statement or equation showing chloride ions changing to chlorine atoms. It is encouraging to note that many candidates performed reasonably well on the calculations, and many relatively low-scoring candidates acquitted themselves well in the two calculations in **Question A2**. However, a minority of candidates used rounded up figures to continue with a calculation. They should be discouraged from doing this as it leads to inaccurate answers.

Comments on specific questions

Section A

Question A1

Many candidates scored all available marks. **Parts (a)** and **(b)** were generally answered correctly, but a variety of answers were seen in **parts (c)** and **(d)**.

- (a)** This was generally correct, the commonest incorrect answer being 'hydrogen', presumably through the candidates thinking that the hydrogen in octane did not combine with oxygen.
- (b)** This was almost invariably correct, with a few candidates suggesting, incorrectly, 'nitrogen dioxide'.

- (c) Most candidates realised that argon was monatomic. The commonest incorrect answer was 'hydrogen', presumably because of its unique position in the Periodic Table. Chlorine and nitrogen were also fairly common incorrect suggestions.
- (d) Oxygen and hydrogen were often incorrectly suggested, the former presumably because of its use (as air) in the blast furnace to burn the coke and the latter because candidates know this as a reducing agent.
- (e) Hydrogen was a common incorrect answer here, candidates perhaps thinking that acids contain hydrogen and therefore this was needed in the Contact process

Question A2

This question was well answered by most candidates and it was pleasing to note that both calculations in **parts (a) and (e)** were generally well attempted. Most candidates gained at least two thirds of the marks available. The main stumbling block to most candidates was the equation in **part (c)**, where the mark for balancing was rarely obtained.

- (a) Most candidates obtained both marks for the calculation and very few failed to score at least one mark. Correct answer 36.8(4)%
- (b) Although the majority of candidates suggested a suitable barium salt to add to test for a sulphate, a few failed to mention the nitric acid. The test for sulphate mentioned in the syllabus does state the inclusion of nitric acid. Some candidates disadvantaged themselves by suggesting that barium sulphate or sulphuric acid should be added. A considerable minority of candidates suggested, incorrectly, that sodium hydroxide should be added. Sodium dichromate was also frequently seen as an incorrect reagent.
- (c) This part was poorly done, with many candidates failing to gain the mark for the correct reactants and products because they did not read the question properly. Although the iron species were usually correct, oxygen often appeared as oxide ions or even oxygen molecule ions, and hydrogen ions appeared as hydrogen molecules. A minority of candidates failed to put oxygen or hydrogen ions in at all. The balance mark was rarely awarded, the commonest error being to forget about the balance of the iron ions.
- (d)(i) Most candidates gave the correct colour change. A few reversed the colour change but the majority of incorrect answers related to the colour change of potassium manganate(VII), i.e. purple to colourless.
- (ii) Although many candidates were able to answer this correctly, it was less well-known than **part (i)**. The commonest answer seemed to be dirty green to reddish-brown, which, although accepted, is a weak answer – it suggests that the candidate is thinking of the precipitate colours of iron(II) and iron(III) ions. A considerable number of candidates merely repeated the orange to green of **part (i)**.
- (e)(i) Most candidates answered this correctly, the commonest errors being 0.01 or 0.0076 (a factor of ten out). Correct answer 0.00076 moles.
- (ii) The commonest error here was to forget to multiply by six, even though the mole ratio was stated in the stem of the question. A not uncommon error was to multiply the moles by 112. Presumably the candidates thought that the iron(II) had twice the molar mass of iron. A number of candidates rounded their answers down to 0.25, which was unacceptable. Correct answer 0.255 g/ 0.26 g.

Question A3

Although this question was well answered by most candidates, **part (c)** provided unexpected difficulties for many and some candidates clearly did not know the correct way of writing the formula for isotopes even though an example had been given.

- (a) Most candidates gained the mark for the correct numbers of subatomic particles. Incorrect answers included 95 or 98 for the number of electrons or 95 for the number of neutrons. Few candidates gave different numbers of protons and electrons.

- (b) About two thirds of the candidates answered this correctly. The most common error was to just write the symbol Tc without any numbers. Where numbers were present, it was often the proton number which caused the difficulty with 42 or 45 being suggested. Hardly any candidates suggested that the mass number was 98 (the number of the isotope given in the question). The few that gave incorrect mass numbers, usually gave those in the forties.
- (c) This part was not done as well as expected. Many candidates wrote incorrectly about valency electrons, full outer shells, lack of mobile electrons or 'no loss or gain of electrons'. Even those who gained full marks often dragged neutrons, unnecessarily, into their arguments. Many candidates wrote vague statements about the protons and neutrons being oppositely charged or 'having a different type of charge' rather than specifying that the charges are positive for the proton and negative for the electron.
- (d) This was generally well answered, most candidates choosing relevant properties of transition elements. Few chose general metallic properties. The commonest errors were to suggest that technetium itself is coloured, to suggest that technetium (the metal) forms coloured solutions, or to merely suggest that technetium is a transition element without referring to a specific property.

Question A4

Most candidates gained at least half marks for this question although the structure of ethane was often not correct and the test for the C=C double bond was not always well-known.

- (a) Many candidates could distinguish between ethane and ethene using the bromine water test, but a considerable number failed to write about ethane and concentrated on the ethene. This often happened because a lot of extraneous information was given, e.g. writing about the product formed or addition reactions in general. A minority of candidates thought that bromine was decolourised by ethane rather than ethene, whilst others lost the marks because they suggested that the ethene was decolourised rather than the bromine. Many gave incorrect statements such as 'ethane remains colourless' or 'the bromine water clears the ethene'.
- (b) The structure of ethane was poorly drawn by many candidates. Ethene and methane were commonly drawn in place of ethane. Although the pairing of electrons was generally correct, some candidates either put another electron on the hydrogen, (as an unpaired electron), or gave bonds involving one electron rather than two.
- (c) The structure of a suitable chloroethane was often drawn correctly. Common errors included drawing a chloromethane, drawing chloromethane plus hydrogen chloride or drawing an alkane.
- (d) Most candidates recognised butene as the alkene with four carbon atoms. The commonest errors were to suggest pentene or butane. Candidates who chose the latter, often failed to gain the marks because they followed by giving the formula C₄H₁₀. The structure of ethene was occasionally seen.

Question A5

Many candidates found this question difficult, but **parts (c) and (d)** were well answered by nearly all candidates.

- (a) (i) There were a wide variety of incorrect responses in answer to this question, many of them not related to the position of phosphorus in the Periodic Table. Apart from P₂O₃, which was not often seen as an incorrect response, the commonest incorrect responses were P₂O, PO₅ and P₅O₂. The last two of these indicated that the candidates had used the idea of the oxidation number of phosphorus being 5, but that the manner of combining the phosphorus with oxygen was not understood.
- (ii) This was poorly done. Few candidates realised the difference between physical and chemical properties. 'It burns' or 'oxidises' was a common answer to either part. Many merely wrote about intermolecular forces or just stated that the oxide was a non-metallic oxide. The best answers referred to (fairly) low melting points or boiling points, (few referred to conductivity), and reacting with water to form an acid.

- (b) Although many candidates were able to write the formulae of potassium chloride and oxygen and copy the formula of potassium chlorate, fewer were able to balance the equation correctly. Many candidates wrote down other compounds, real or imaginary, often containing phosphorus, e.g. POCl_3 , $\text{P}_2\text{Cl}_4\text{O}_2$.
- (c) The equation was generally written incorrectly. Common errors included writing S_2 in place of S or incorrect balancing.
- (d) Nearly all candidates answered this correctly.

Question A6

Most candidates scored well on this question. **Parts (a)(i)** and **(c)** appeared to be the most demanding. As in previous years, the answers to the environmental questions were often rather vague.

- (a) (i) The commonest correct answer was 'volcanoes'. Many candidates wrote vaguely about acid rain and burning fuels, without specifying the fuel. Such answers were not accepted because the stem of the question talks about the combustion of coal at a power station. A considerable minority of candidates wrote about sulphur dioxide being produced during the manufacture of sulphuric acid (despite the fact that they should know that the gases are recycled).
- (ii) Most candidates realised that nitrogen dioxide is produced in a car engine but many wrote simply 'from cars' or 'in motor transport', which were too vague. Many suggested that bacterial decomposition or fertilisers produce nitrogen dioxide.
- (b) (i) The correct answer, carbon dioxide, was the answer most frequently given, but many candidates suggested oxygen or hydrogen.
- (ii) Most candidates successfully recognised calcium nitrate or nitrite as the answer. The most common errors were calcium oxide, calcium nitride and nitrogen carbonate.
- (iii) Many candidates recognised a suitable effect of acid rain but a large number of answers were very vague or suggested that buildings were being destroyed (indicating complete demolition). It is encouraging to note that few candidates thought that acid rain was linked to global warming.
- (c) This was often well done, with many candidates scoring full marks. However, many candidates did not recognise the activation energy or enthalpy change. A number of candidates failed to make clear which of the data lines referred to the reactants and which to the products, and several provided no data lines but made a continuous curve where the reactant and product levels should have been. The lines representing the activation energy and enthalpy change were often muddled, or the incorrect activation energy given. Very often, the activation energy or enthalpy changes were just arrowed at the top or bottom of the curve, and a considerable number of candidates just wrote H2 and H1 on the vertical axis and assumed that was good enough to describe the enthalpy change.

Section B

Question B7

Many candidates performed well on this question especially in **parts (b)** and **(d)**. It was encouraging to note that in **part (c)** many candidates had a reasonably good grasp of practical procedures, although this was not always well expressed.

- (a) Many candidates did not read the instruction to write an ionic equation, and wrote a full equation. Of those who wrote an ionic equation, the commonest error was a lack of balance of the halides. Few candidates followed the word 'describe' in the stem of the question to write about the colour change of the solution. The most commonly obtained mark was for an explanation of the meaning of reduction in the context of the equation. However, quite a few candidates disadvantaged themselves by stating, either in writing or in an equation, that chloride ions lost electrons, together with correctly explaining that the chlorine atoms accept an electron.

- (b) Many candidates drew good dot and cross diagrams of the magnesium and chloride ions. There appeared to be fewer cases of candidates placing the charges in the nucleus than in previous sessions. Common errors included leaving two electrons on the outer shell of magnesium, omission of the inner shells of electrons, lack of any electrons in the outer shell of magnesium, and lack of any charge. It is encouraging to note that there were fewer instances than usual where candidates drew covalent structures.
- (c) Most candidates obtained at least half of the available marks for this part. Many candidates failed to suggest that the silver nitrate should be in solution (in water). A wide variety of chlorides were suggested as the second reagent, sodium chloride being the most popular (as was hydrochloric acid). A not insubstantial number of candidates disadvantaged themselves by suggesting that silver chloride should be added. Many candidates who suggested that hydrochloric acid should be added thought that a titration was required and also mentioned an indicator. Very few candidates suggested the incorrect method of adding an oxide or hydroxide, although quite a few thought that chlorine would react with silver nitrate. Most candidates obtained the mark for filtration, but a few suggested that the 'filtrate' should be filtered or that the silver chloride was the filtrate. Although most candidates suggested a suitable form of drying, many were just content to let the water trapped in the precipitate, evaporate, and only a minority mentioned washing the precipitate. This last part was rather Centre dependent.
- (d) Most candidates obtained the mark for realising that CFC's deplete the ozone. Some candidates lost marks because they implied that the whole ozone layer had been destroyed.

Question B8

Although this was a fairly popular question to be chosen, few scored more than half the marks available. **Parts (b)(ii) and (d)(ii)** proved stumbling blocks for practically all candidates. In the latter, careless writing of the CH_3 group in the polymer occasionally lost candidates' the mark.

- (a) This was generally answered correctly, the commonest errors being to suggest that it was the size, or vague statements such as the temperature of the gasoline.
- (b)(i) The candidates gave a wide range of responses to this question, often using vague statements referring to substances, raw materials or unspecified compounds. The idea of breaking large or long hydrocarbons or alkanes into smaller ones was not always made clear. Although cracking is an example of thermal decomposition, this was not accepted as an answer because not all thermal decomposition is cracking. The conditions for cracking were rarely given.
- (ii) Most candidates had difficulty with explaining the concept of cracking less useful fractions to make more useful fractions, despite the fact that many candidates had mentioned this in **part (i)**. There were many vague statements such as 'the fractions higher than gasoline are cracked to make gasoline'. This is not accurate enough as the kerosene fraction is heavier than the gasoline fraction but is unlikely to be cracked because its supply is less than that of its usage. Many candidates failed to name the specific fractions required in the answer. Another group of unacceptably vague statements centred round statements about cracking crude oil or petroleum rather than particular petroleum fractions.
- (c)(i) Just over half the candidates drew the structure of propene correctly. Common errors included five bonds round the central carbon and only two at the terminal carbon not involved with the double bond, lack of hydrogen atoms, and drawing pentene or butene rather than propene.
- (ii) Although most candidates chose $\text{C}_{12}\text{H}_{26}$ as the alkane produced when pentadecane is cracked, a number of other correct alternatives were seen. Unfortunately some of these did not include propene as required by the question. Another error was to give the alkane an incorrect formula e.g. $\text{C}_{12}\text{H}_{28}$ or to give the formula with an odd number of hydrogen atoms.
- (d)(i) Descriptions of the conversion of propene to propanol were varied. A hydrogen atom was often left off the terminal CH_3 of propanol and occasionally the hydrogen atoms were not present at all. The formulae for ethanoic acid or esters were occasionally given. A considerable number of candidates failed to gain the mark because the terminal OH group was attached to the carbon atom via hydrogen rather than oxygen, i.e. $\text{C} - \text{H} - \text{O}$. The conditions for formation were often given but many lost the mark because they failed to mention that steam, rather than water, is used (water + an indication of a temperature above 100°C was accepted in place of the word 'steam').

- (ii) The correct formula for poly(propene) was rarely seen. Most candidates drew the formula for poly(ethene) or failed to gain the mark because they did not include the extension bonds. Of those who did realise that there were methyl groups on every other carbon atom in the chain, many spoilt their answers by either putting 'n' in front of a condensed drawing in square brackets or made inaccurate drawings with the bonds from the carbons attached to the hydrogens rather than the carbon of the methyl group.

Question B9

Most candidates found **parts (b) and (c)(i)** of this question quite demanding. Most candidates recognised the hydrogen ions as being common to all acids. On the other hand, the equation in **part (c)(i)** was rarely correct.

- (a) Nearly all the candidates scored the mark for recognising the ion present in acids. A few candidates went further than requested and wrote out the symbols/ formulae for all the ions present in aqueous solutions of hydrochloric and ethanoic acid. This was not necessary and does not answer the question. The main error was to suggest that the OH^- ion was responsible for acidity.
- (b)(i) Although many candidates showed a good ability at calculating moles from masses and from concentrations and volumes, fewer could use the stoichiometry of the equation to suggest convincingly which species was in excess. The commonest error was to ignore the equation and suggest that neither the magnesium nor the hydrochloric acid was in excess. A large minority used the equation incorrectly and multiplied the moles of hydrochloric acid by two (correct answer 0.01 moles Mg and hydrochloric acid, but two moles of acid required for every mole of magnesium, so magnesium is in excess).
- (ii) The ideas behind the calculation proved quite difficult for many candidates although many were able to gain at least one mark through carrying forward an error. Many failed to use the stoichiometry of the equation to calculate the moles of magnesium chloride and some inexplicably used 59 instead of 95 for the molar mass of magnesium chloride (correct answer 0.475 / 0.48 g)
- (iii) Few candidates scored full marks for this part and even fewer tried to relate the hydrogen ion concentration to rate of reaction. Most candidates scored a mark for realising that ethanoic acid is a weak acid and hydrochloric acid is a strong acid, but fewer explained the meanings of strong and weak in terms of differences in ionisation. Many candidates failed to gain marks because they did not compare the two acids, concentrating only on the ethanoic acid and not even giving comparative words such as 'ethanoic acid is weaker'. The better candidates scored a mark for realising that the same number of moles of acid were present, but many just referred to the concentration of acid and not to the volume as well. Few candidates scored the marks for relating rates to concentration of hydrogen ions or for the collision rate.
- (c)(i) Very few candidates were able to write the correct equation for the reaction of ethanoic acid with sodium carbonate. A small minority did not read the question properly and wrote an equation for the reaction of magnesium with ethanoic acid. Although it was encouraging to note that many candidates could write the formula for ethanoic acid correctly, it was disappointing from the Examiners' point of view that so few knew the formula for sodium carbonate – it was invariably given as NaCO_3 . Of those who were able to write the formulae correctly, only a few recognised that the equation needed to be balanced by putting twos in front of the organic species.
- (ii) Many candidates failed to give an observation such as 'effervescence' or 'sodium carbonate dissolves'. Many were content to suggest that a gas or carbon dioxide was given off. The word observation refers to what can be seen, heard, felt or smelt. Many thought, incorrectly, that a white precipitate would be formed.

Question B10

This question was marginally less frequently answered than the other **Section B** questions. It also appeared to be one where candidates wrote too much, especially in **parts (a)**. The quality of the diagrams showing the structure of a metal, were generally very poor. Diagram quality is an area which needs improvement in general. Many candidates were able to do the calculation in **part (c)**, but few gained full marks for the analysis question in **part (d)**.

- (a) There were many poor diagrams of metallic structure. Many candidates failed to show the ions and just drew a row or several rows of metal atoms which were often slightly different sizes. The main errors were making the positive ions different sizes, lack of regularity in the ions in the structure, drawing the ions too far apart so that they appear to be the particles in a gas, massing the electrons in whole groups around a group of ions without any electrons between the ions themselves, showing the electrons as dots still attached to the outer shells of the atoms, and making reference to the ions as protons. The Examiners expected that the electrons should be drawn spaced out throughout the whole structure, which was often not the case. Many candidates wrote about layers of atoms sliding over each other, which was totally irrelevant to the question. A significant number of candidates drew three-dimensional lattice-like structures without showing ions.
- (b) Although this was slightly better answered than in previous sessions, many candidates failed to gain the mark because they did not refer to the movement of the electrons. As mentioned in previous Examiner Reports, the phrase 'free electrons' is not sufficient to gain the mark. A large number of candidates wrote too much and mentioned ions, electrostatic forces and Van der Waals forces. All that was required was the phrase 'the electrons are mobile', rather than six or seven lines of irrelevant information.
- (c) (i) Most candidates correctly mentioned the increased surface area of the powder compared with the lump.
- (ii) The calculation was fairly well done but many failed to calculate the moles of hydrogen correctly before proceeding to **part (iii)**. Many omitted this step and went straight on to multiply some other number by 65 (correct answer: moles hydrogen = 0.003; mass of zinc = 0.195 g).
- (iii) Most candidates could do a percentage by mass calculation. A large minority of candidates gained follow through marks from an incorrect answer in **part (ii)** (correct answer = 16.25/ 16.3%)
- (d) Although many candidates scored well, few realised the importance of the phrase 'only the zinc' in the stem of the question, and subsequently ignored what would be observed if copper reacted with the acid. Many candidates realised that a white precipitate would be formed but a considerable number suggested, incorrectly, that this precipitate would be insoluble in excess ammonia.

CHEMISTRY

<p>Paper 5070/03</p>

<p>Practical Test</p>

General comments

The overall standard was encouraging with many candidates demonstrating good practical skills in both the quantitative and qualitative questions.

Comments on specific questions

Question 1

- (a) Candidates were required to decide whether the acid **P** was hydrochloric acid or sulphuric acid by adding **P** to aqueous lead(II) nitrate, aqueous silver nitrate and aqueous barium nitrate. Most candidates correctly reported white precipitates with both lead(II) nitrate and barium nitrate and no reaction with silver nitrate, these observations confirming that **P** was sulphuric acid. Although most candidates did specify white precipitates, many referred to white or milky solutions.
- (b) The acid/base titration was generally well done and many candidates achieved full or nearly full marks for this part of the exercise.

Full marks were awarded for 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 all titration exercises, candidates should repeat the titration as many times as necessary, until they have obtained consistent results. They should then average these consistent results, having first 'ticked' **all** of them to indicate that these are their most accurate values. Although many candidates do carry out this procedure carefully, a significant number still tick only one result (or none at all) and often use another value in the summary. When carrying out titrations, candidates are expected to use their chemical judgement and sometimes reject some of their values.

- (c) The calculation proved to be more difficult than expected, because many candidates had forgotten that because the acid was sulphuric acid, the mole ratio was 2:1, $\text{NaOH}:\text{H}_2\text{SO}_4$.

Those candidates who had incorrectly identified the acid as hydrochloric acid could use this answer here without additional penalty. Answers were required to three significant figures not 3 decimal places, a number of candidates lost a mark by over-approximating.

Question 2

Marks for this question were generally high. Marks were usually lost for incomplete rather than incorrect answers. It was not necessary to make all the observations to obtain full marks for this question.

S was iron(III) chloride, **T** was copper(II) sulphate and **U** was nickel(II) sulphate.

Test 1

S gives a red-brown precipitate with aqueous sodium hydroxide which does not dissolve in excess alkali. A range of colours was accepted for this precipitate. **T** gives a blue precipitate which again does not dissolve in excess. Most candidates scored all these marks. With **U** the precipitate is green, although many candidates thought it was white. It is also insoluble in excess.

Test 2

With ammonia, **S** gives the same red-brown precipitate which is again insoluble in excess. With **T**, a blue precipitate is formed and this redissolves in excess to give the characteristic dark blue solution. A disappointing number of candidates either added the ammonia too quickly and failed to note the initial precipitate or failed to mention the final colour of the solution. It was clear that in a number of cases, candidates had failed to mix the reagents, which led to descriptions of different layers which usually lost marks. The reactions with **U** were more difficult, the addition of a small amount of ammonia produces a faint blue (not green) precipitate which readily dissolves to give a solution which is less intense than the one produced with **T**. A large proportion of the candidates saw only the final blue solution.

Test 3

With aqueous potassium iodide, **S** gives a solution that is much darker/redder than the initial solution. If the experiment is carried out correctly, there is no black precipitate of iodine. The reaction with **T** is complex, but allowing the mixture to stand makes it easier to see that there is a white precipitate in a brown solution. A range of 'pale' colours was accepted for the precipitate, but it was necessary to report both the colour of the precipitate and the colour of the solution to score full marks. With **U** there is no reaction. Candidates should be encouraged to realise that there are some tests which will not produce a visible change and in these cases 'no reaction' is a perfectly acceptable observation.

Test 4

There is no reaction between **S** and barium nitrate, whilst **T** gives a white precipitate in a blue solution. Allowing the mixture to stand makes it very clear that the precipitate is white and not pale blue.

Test 5

In a similar way, **S** produces a white precipitate in a yellow/brown solution when reacted with silver nitrate, but **T** does not react.

Conclusion

Candidates were required to give the formulae of **S** and **T** (FeCl_3 and CuSO_4) but a surprising number gave only the formulae of the positive ions (Fe^{3+} and Cu^{2+}) and although this gained some credit it was not what candidates were asked to do. Full marks for the conclusions required candidates to have reported the correct colour of the precipitates formed with aqueous sodium hydroxide and to have reported precipitates of any colour with only one of barium nitrate or silver nitrate.

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.

A major concern is the continuing confusion of the tests for oxygen and hydrogen. A typical example is the test for hydrogen stated as 'a glowing splint' pops in a flame.

Report on Individual Questions

Question 1

The diagram shows a pipette with the volume calibration line below the bulb. Other acceptable answers included, the bore on the lower part of the pipette being too wide.

Question 2

- (a) The mass of sodium carbonate crystals used in the experiment was 4.04 g.
- (b) After heating, the crystals became a white powder.
- (c) (i) The mass of sodium carbonate remaining after heating was 1.52 g (ii) 2.52 g of water were lost.
- (d) The relative formula masses of sodium carbonate and water are 106 and 18 respectively which are used in
- (e) to calculate the number of moles of (i) sodium carbonate 0.0143 and (ii) water 0.140.
- (f) The value of x in the formula is obtained by dividing 0.140 by 0.0143 giving 9.80. As x must be a whole number the value of x is 10.

Candidates, who approximated 0.0143 to 0.014, lost a mark as did candidates who produced an answer of 10 without showing their calculation.

Any incorrect answers in **parts (a), (b) or (c)** may be used in subsequent parts of the question and obtain appropriate marks.

Question 3

- (a) (i) Chlorine was produced at the anode which (ii) bleached the litmus solution, (iii) this being a positive test for chlorine.
- (b) (i) Hydrogen was evolved at the cathode (ii) whose presence may be confirmed by a 'pop' in a flame. (not using a glowing splint as many candidates stated).
- (iii) The colour of the solution around the cathode went blue (iv) resulting from an excess of hydroxide ions following the removal of hydrogen.
- (c) The solution may be replaced by hydrochloric acid to give similar results.
- (d) The electrolysis of molten sodium chloride would give sodium at the cathode.

This proved to be a difficult question but most candidates obtained marks for correct tests for chlorine and hydrogen.

Questions 4 to 8

Correct answers are (d), (c), (d), (d) and (b) respectively.

Question 9

- (a) A pipette should be used to measure out 25.0 cm³ of solution.
- (b) Tests for ammonia include litmus turning blue or white fumes when a glass rod dipped into conc. hydrochloric acid is exposed to ammonia.
- (c) The colour change of methyl orange was yellow to orange, red or pink.
- (d) The correct titres were 27.2, 26.4, and 26.6 cm³. These values gave an average of 26.5 cm³. Incorrect burette readings would give different titres but so long as the correct appropriate mean was chosen no further marks would be lost. The answers to the calculations were
- (e) 0.00212, (f) 0.00212, (g) 0.0212, (h) 0.05, (i) 0.0288, (j) (i) 0.0288 moles, (ii) 1.15 mol/dm³.

Candidates must not approximate these values as the purpose of titration is to produce accurate results. Any error in a calculation may be correctly used in subsequent parts and obtain the available marks.

This was, in general, a well answered question with a large number of candidates scoring full marks.

Question 10

- (a) A colourless solution was obtained on dissolving T in water.
- (b) The results of the addition of aqueous sodium hydroxide suggested the presence of aluminium or zinc ions
- (c) The results of the addition of aqueous ammonia confirmed the presence of aluminium ions.
- (d) The test for nitrate ions involves the addition of aqueous sodium hydroxide and aluminium metal. On heating, ammonia was evolved which may be confirmed with litmus.

Although the chemistry of lead is not on the syllabus, a number of candidates correctly suggested that the test results indicated the presence of lead ions and marks were awarded accordingly.

Any incorrect ion suggested in (b) and/or (c) was penalised.

Question 11

- (a) Two marks were awarded for a correctly balanced equation.
- (b) Candidates were asked to measure the heights of the precipitates in the test tubes in mm. The correct heights were 8.0, 16.0, 24.0, 28.0 and 28.0.
- (c) Candidates were instructed to plot these height measurements on the grid and to join the points with two intersecting straight lines. The lines crossed at the point, 28.0 mm/7.0 cm³. Common errors included joining the third and fourth points with a curve or joining the points with three straight lines. Marks were deducted in the latter two cases. Candidates should be advised to always connect the points as instructed to gain the available marks.
- (d)(i) The minimum volume of **H** taken from the graph (where the two lines intersected) was 7.0 cm³ although the mark is always awarded for the candidate's correct reading of their own graph.
- (ii) Using the equation in (a) which should show a mole ratio of 2:1 for KI /Pb(NO₃)₂ and the answer to (d)(i), the concentration of potassium iodide may be calculated, the correct answer was 3.5 mol/dm³.
- A different mole ratio, based on an incorrect equation, may be used in the calculation and, if correct, will gain the available marks.
- (e) On repeating the experiment using a more concentrated solution of lead(II) nitrate, half the volume (3.5 cm³) would be needed to react with the potassium iodide, but the height of the precipitate would be the same as the same number of moles of lead(II) iodide would be produced.