

CHEMISTRY

Paper 5070/01
Multiple Choice

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

General comments

Six questions, in particular, were very much to the candidates liking but even these questions proved to be most useful in discriminating between the candidates.

Comments on individual questions

Question 5

The H⁻ ion has one more electron than the H atom. An H⁺ ion has no electrons therefore a hydride ion has two more electrons than the H⁺ ion. Thus the popular alternative **C** was incorrect.

Question 13

Alternatives **A** and **D** were incorrect because reduction is the loss of oxygen and in **A** and **D** on the supposed reducing agents was oxygen.

Question 15

Candidates choosing alternative **A** more than likely had not read the question with sufficient care.

Question 17

The addition of a catalyst was a very popular, though incorrect, answer to this question. Catalysts achieve equilibrium in a shorter time but the amount of product formed at equilibrium is the same. Catalysts increase the rates of both the forward and backward reactions, equally.

Question 18

This question required a thorough knowledge and understanding of how electricity is conducted. Graphite and all metals conduct electricity due to the movement of electrons and ionic compounds conduct electricity due to the movement of ions.

Question 30

This question tested knowledge of the manufacture of iron and the manufacture of aluminium. The realisation that the electrolysis of a metallic oxide to remove oxygen, is a very expensive process, and is therefore only done when other less expensive chemical methods of reduction are not possible provides another method of solving this question.

Question 31

As many candidates chose the incorrect alternative **C** as chose the correct alternative **D**, most likely due to a failure to include the H of the OH in the number of hydrogen atoms.

Question 36

Each of the options proved to be quite popular, although over 50% of the entry correctly identified the correct alternative **C**. The vegetable oils Q, R and S were each unsaturated, but to varying degrees, as each reacted with hydrogen.

CHEMISTRY

Paper 5070/02

Theory

General comments

Many candidates tackled the paper well and good answers were seen in many parts of the paper e.g. **Questions 1 and 2** (and to a lesser extent **Questions 3 and 4**). In general, the rubric was well interpreted and most candidates attempted all parts of each question. A considerable number of candidates who scored well on **Section A** failed to maintain this standard in **Section B**. In **Section B** many candidates gave unnecessarily lengthy answers to some questions e.g. **Question B 8(b)**. 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. The use of bullet points is acceptable. The standard of English was generally good but there was one misconception which nearly all candidates should address: the use of the word 'marine'. In several places throughout the paper, but especially in **Question B8**, this word was used synonymously to mean 'water'. The word marine means 'of the sea' and is not therefore applicable to rivers, lakes etc. In **Section B** the least popular question was **B10** and this was also reflected by the generally poor marks that even good candidates obtained for this question. As has been commented on in previous Principal Examiner Reports, many candidates have a poor knowledge of tests for specific ions and fail to give essential details about the procedures or fail to report full observations. Most candidates' knowledge of atomic structure and the properties of elements related to the Periodic Table was good but many were found to have a poor knowledge of general organic reactions and formulae. For example, many could not write the correct formula for propene. A considerable number of candidates had difficulty in writing quite simple symbol equations and the concept of ionic equations seemed lost on all but a very few. The relationship between structure and properties remains a problem area for many candidates. This was exemplified in this paper by the poor marks obtained in **Question A5**. A considerable number of candidates confused ionic and covalent structures. There were only a few instances where candidates disadvantaged themselves by giving multiple answers. Those cases which did occur were seen most often in **Question A7(a)(ii)** and **A7(c)(i)** where destruction of the ozone layer, acid rain and 'greenhouse gases' were all muddled up. It is encouraging to note that nearly all candidates confined themselves to a single answer in questions such as **A1** and **A4(c)**. In more extended questions, candidates often disadvantaged themselves by sloppy and non-specific writing. As in previous examinations, few candidates explained environmental effects in a convincing way. It was encouraging to note, that many candidates appreciated the correct method to do the calculation questions. These questions provided many of the poorer candidates with a considerable proportion of their marks.

Comments on specific questions

Question A1

Most candidates tackled this question well and many obtained at least four-fifths of the marks available. Parts **(c)** and **(e)** gave most problems. Only a few candidates penalised themselves by writing formulae instead of names.

- (a)** The most common errors were to suggest that phosphorus or iron were catalysts for the hydrogenation of alkanes rather than nickel. The reason for the former is unclear.
- (b)** This was generally answered correctly with most candidates selecting aluminium. Iron or nickel was the commonest incorrect answer. The former was more surprising, seeing that the extraction of iron is on the syllabus.

- (c) A wide range of incorrect answers was given here. Argon or sodium often appeared as answers.
- (d) Most candidates realised that phosphorus (or nitrogen) form ions with a negative charge but they did not gain a mark for part (c). Argon was again frequently seen as an incorrect answer.
- (e) The most frequent incorrect answer was 'sodium' (although occasionally 'phosphorus' was seen). In some cases this arises from the candidates not reading to the end of the question, where the important words 'coloured solution' were to be found.

Question A2

Most candidates tackled this question very well and many obtained at least four of the five marks available. Those who did not score full marks tended to lose the marks in part (d).

- (a) Nearly all candidates gave the correct answer, C and only a few chose the incorrect answer B, which is the mass number rather than the atomic number.
- (b) Nearly all candidates gave the correct answer, C, the commonest incorrect answer being D (obtained through counting the number of protons or neutrons alone).
- (c) The correct answer D and E was chosen by most candidates. The incorrect answer, A + B, not infrequently seen, was presumably arrived at through candidates not reading the key correctly.
- (d) The number of protons was almost invariably correctly identified by the candidates. The commonest errors were to suggest that there were 39 neutrons, that there 19 (or 20) electrons in the potassium-39 ion or that there were 21 neutrons in the potassium-39 ion.

Question A3

Most candidates tackled this question reasonably well and many obtained about two-thirds of the marks available. No particular part proved more difficult than another.

- (a)(i) Candidates were prone to use the word 'similar' rather than the 'same' chemical properties. Most candidates obtained the mark by referring to a difference in successive member of a CH₂ group. Fewer candidates referred to the gradation of physical properties. A few penalised themselves by referring to a gradation in physical (correct) and chemical (incorrect) properties or the same chemical (correct) and physical (incorrect) properties. Only a few commented on the fact that the functional group is the same. Some candidates failed to obtain the mark because they wrote 'has the same general formula'. This merely repeats the question.
- (ii) Most candidates wrote the correct answer C_nH_{2n}. The commonest error was to write the general formula for an alkane, C_nH_{2n+2}. This presumably arose because these candidates focused on the 'propane' part of the word 'cyclopropane' rather than considering the formula.
- (b)(i) A pleasing number of candidates scored both marks, with some getting the correct formulae but balancing incorrectly. One of the commonest loss of marks was due to the non-balancing of the oxygen.
- (ii) Less than two-thirds of the candidates wrote the correct answer – 'substitution'. The commonest incorrect answer was 'addition' although other incorrect answers such as 'displacement' or 'halogenation' were occasionally encountered.
- (c) Although many candidates identified propene as the isomer of compound D, a number put propane, butene or butane. A minority of candidates suggested strange names such as 'methyl ethene'. The structure mark was regularly awarded but many candidates put two hydrogen atoms on the middle carbon or drew the methyl group without its third hydrogen atom. Some candidates drew branched chain structures.

Question A4

This question was generally well answered by most candidates, the calculation being well presented and the correct answer even by candidates who performed badly in other parts.

- (a) Most candidates realised that calcium carbonate breaks down to calcium oxide and carbon dioxide but a few thought that the gaseous product was oxygen. Some candidates constructed an equation for 'combustion' of calcium carbonate, putting oxygen on the left. Yet others suggested that calcium carbonate reacts with water.
- (b)(i) This was generally well answered some candidates put incorrect formulae e.g. Ca_2O , CaO_2 , CaOH . A not inconsiderable number added hydrogen as a product.
- (ii) Although this part was well answered on the whole, too many candidates missed the name and gave the formula for calcium carbonate. Calcium oxide and calcium hydroxide were common incorrect answers. The latter was not accepted because no water was stated to be present.
- (c) Most candidates could give a sensible use for calcium hydroxide. Most suggested that it was used to neutralise acidic soils. Since the question asked for a large scale use, answers such as for limewater were not acceptable. A considerable number of candidates thought that calcium hydroxide was used in making cement or plaster (rather than calcium carbonate and calcium sulphate respectively).
- (d) A pleasing number of candidates scored three marks for the calculation. Of those who did not, it was often a miscalculation in one of the formula masses which contributed to the loss of a mark. A small number of candidates made a serious error of multiplying some of the atomic masses to calculate the formula mass e.g. formula mass of $\text{Ca} \times$ formula mass of 2xOH . Correct answer = 444g.

Question A5

Most candidates found this question challenging with the consequence that scores of more than 2 out of 6 were the exception rather than the rule. As has been commented on above, candidates find the relationship between properties and structure a difficult concept to understand.

- (a) Few candidates calculated the correct ratio of silicon and carbon atoms (SiC). $\text{Si}_{19}\text{C}_{19}$ was frequently seen but numerous other incorrect answers involving different ratios were commonly encountered, SiC_3 being chief amongst them. Many candidates included oxygen in the formula even though there was none shown in the diagram: another case of candidates not accessing the key properly. Several candidates failed to put down the correct symbol for silicon, the symbol for sulphur being used in its place.
- (b) The majority of candidates who were aware of the idea of electrons being involved only used ideas of them being just 'free' rather than being mobile. Many referred to a 'sea of electrons' which was not accepted because this term generally refers to metallic structures. Unfortunately, it was all too common for candidates to invoke the movement of ions or atoms. Many just referred to graphite and therefore lost the mark for stating that silicon carbide has no delocalised/mobile electrons.
- (c)(i) Fewer than one in every ten candidates obtained the mark for this part of the question, mainly because they referred to intermolecular forces rather than covalent bonds. Those who did get the correct idea about strong bonds did not usually tie it in to the idea that there are 'many' or 'lots of' these strong bonds. This was often further compounded by the use of the word 'molecule' for the structure. Although many texts give the term 'macromolecule' for this type of structure, candidates would be advised to use the term giant structure of atoms in its place. The word 'macromolecule' all too often leads candidates to omit the 'macro' part of it. Many candidates also disadvantaged themselves by writing about electrostatic forces, thus suggesting that the structure is ionic.
- (ii) This was not generally well answered because many candidates insisted on using the terms 'intermolecular forces', 'electrostatic bonds' and 'macromolecules'. The question required a comparative answer i.e. 'stronger bonds' rather than just 'strong bonds'.

- (d) Most candidates performed well on this part of the question. The answer 3.2 was a common incorrect answer. Some candidates performed some sort of calculation, not realising that the answer merely depended on the idea that diamond and graphite are allotropes of carbon.

Question A6

Most candidates tackled this question reasonably well and many obtained about half the marks available, with the part (d) marks being most difficult to score.

- (a) Candidates as a whole regularly scored one of the two marks, but they often discussed the reaction in terms of 'very reactive with water', 'hydrogen given off' or 'reacts completely' rather than giving specific observations. Candidates should understand that the word observations means what you see, hear, smell (or feel to the touch).
- (b) This part was reasonably well answered by about half the candidates, but many failed to balance the equation with the 2's. The commonest incorrect formulae seen were LiO and Li(OH)_2 .
- (c) A pleasing number of candidates knew the definition of oxidation in terms of electron loss and increase in oxidation number. If candidates referred specifically to a lithium atom (rather than lithium atoms in general), they were penalised if they implied that more than one electron was removed from the atom. A small number of candidates did not read the question properly and wrote about oxidation in terms of oxygen gain or loss of hydrogen.
- (d) This part was least well done in the question. As with part (i), many candidates discussed the reaction in abstract rather than observational terms, writing about trends down the group or 'rapid reactions'. Fewer candidates gave specific observations based on the difference between the reactions of lithium and rubidium. More than a third of the candidates suggested that rubidium was less reactive than lithium.

Question A7

Most candidates tackled this question reasonably well and many obtained at least half the marks available. Parts (a)(ii), (b), (c)(i) and (c)(ii) posed most problems. As has been commented on in previous Principal Examiner Reports, many candidates seem to muddle environmental issues related to the atmosphere.

- (a)(i) This part was generally well answered with only a few candidates not appreciating that they needed to base their responses on the graphs given rather than their general knowledge. A common incorrect answer was 'the carbon dioxide concentration and the temperature have both been increasing during this time'. This is incorrect because it suggests that the carbon dioxide concentration and the temperature have both been increasing steadily over the past 150 000 years'. As in last November's Paper (5070/02), many candidates gave an incorrect reading of the figures on the horizontal axis of the graph by ignoring the 'thousands of years'. Candidates were not penalised on this occasion but should be instructed to inspect carefully the numerical values shown on graphs, especially if they involve years as units.
- (ii) Many candidates failed to gain the mark here because they wrote about flooding in general rather than referring to melting of the polar ice caps. Just referring to ice melting was not enough to gain the mark. A few candidates spoil their answers by including 'affects the ozone layer'.
- (b) The diagrams for the electronic structure of carbon dioxide were often incorrect and few candidates obtained both marks. Common errors were: (i) to draw only one bonding pair (ii) to draw an incorrect sort of carbon monoxide structure (iii) to put in two extra unbonded carbon electrons (iv) to miss out the non-bonding oxygen electrons. A considerable number of candidates thought that carbon dioxide was ionic.

- (c)(i) Many candidates put carbon dioxide or carbon monoxide rather than methane as a greenhouse gas. Sulphur dioxide was often seen as an answer, lending further credit to the suggestion that many candidates confuse the processes of global warming, acid rain and ozone depletion.
- (ii) Candidates who gained the mark for part (i) almost invariably scored the mark for suggesting a suitable natural origin for methane.
- (iii) The majority of candidates gained both marks for the ozone depletion question. A number of candidates disadvantaged themselves by implying that CFCs are 'unreactive and so react with ozone'. Although CFCs are stable under normal atmospheric conditions, an answer such as the one quoted here cannot be given credit as it is contradictory.

Question B8

This was a popular question with candidates, but few achieved high marks because their responses were rather vague and did not correspond with the major points required. For example, in part (b) many candidates wrote extensively about how fertilisers get into the river rather than concentrating on the process of eutrophication. The calculation part of this question proved to be the most challenging of the calculations in this Paper.

- (a) Candidates tended to discuss the source of phosphates from the point of view of run-off from the land or how phosphates get into the river water rather than by answering the question with the simple answer 'from fertilisers (running off)'
- (b) This part was poorly answered by many candidates, many of whom wrote far too much (see general comments). The idea of increased or excessive algal growth or algal bloom was very often not explained well enough. Statements such as 'the algae start to grow' or 'phosphates provide nutrients for the algae to grow' do not go far enough to get the mark. Worryingly, many candidates seemed to suggest that algae developed into bacteria. Many wrote about plants in general rather than algae covering the surface. The idea of algae blocking the sunlight was often missed. Candidates often knew that there was oxygen depletion but usually discussed this as being caused by the growth of the algae rather than the bacteria. Candidates should be reminded that algae are green plants which photosynthesise and therefore give off oxygen during the day. The question referred to eutrophication in a river. Many candidates ignored this and wrote about lakes and seas and generally that animals die rather than the plants. Nearly all candidates referred to marine organisms dying (see the general comments above on the incorrect use of the word marine).
- (c)(i) Although many candidates knew the test for a nitrate with aluminium and sodium hydroxide, some forgot that the reaction mixture needs to be heated. However, the second mark was still available for the idea that ammonia is given off. A not inconsiderable number of candidates suggested that acid should be added instead of or in addition to alkali and some compounded this by suggesting that nitric acid should be added! This probably arises from the idea that in testing for ions, the compound should be made into a soluble form first.
- (ii) Very few candidates appreciated that the concentration of nitrate in river water may be too dilute to measure using this particular nitrate test. The majority suggested potential problems with the interference of other 'substances' (generally unspecified) – and this despite their knowledge/experience of the process of qualitative analysis. However, if the specific contaminating substance mentioned was ammonium compounds, credit was given.
- (d) The calculation proved difficult for the majority of candidates. A major error was to use 127 for the molar mass of iodine rather than 254. Many worked out moles of water rather than moles of oxygen or worked out moles of water, then moles of oxygen or tried to use the idea that 1 mole of gas occupies 24 dm³ at RTP. Correct answer 0.0005 mol/dm³.

Question B9

Candidates found this question rather challenging as it involved a fairly wide range of ideas. Although candidates obtained all three marks on the calculation, many scored low marks for parts (a) and (b)

- (a) Very few candidates were able to write the correct ionic equation for the formation of an ammonium ion. Many spoilt it by giving the ammonia a charge (a negative charge seemed just as common as a positive) or writing an uncharged product i.e. NH_4Cl or NH_4 .
- (b) For the preparation of potassium chloride, few candidates chose the correct reagents and even fewer were able to take it through a titration with, then without indicator. Most, however, were able to obtain the mark for crystallisation as long as they had chosen the correct reagents. Many candidates suggested that potassium should be reacted with acid – a rather too dangerous experiment to carry out either in the lab or to scale up for larger quantities. The incorrect suggestions for starting reagents are too varied to mention and some did not even involve potassium or chlorine. Combinations involving two salts were sometimes incorrectly given e.g. potassium nitrate and sodium sulphate.
- (c) Most candidates scored all three marks in the calculation. Using atomic numbers rather than relative atomic masses was a common mistake. Some candidates failed to use the correct formulae for potassium sulphate or potassium carbonate, despite these appearing in the question.
- (d) Candidates obtained the mark for charges more often than the mark for the electronic structure. Common errors were (i) to fail to draw all the shells (ii) not drawing the correct numbers of electrons in each shell through carelessness (iii) drawing the structure of the atoms rather than the ions (iv) drawing a covalent arrangement (see also comments on **Question 7(b)** for the lack of understanding of which structures are covalent and which are ionic)

Question B10

This question was not often chosen by candidates and those who did so, rarely scored high marks, few scoring more than five out of the ten marks available. The poor responses reflect the fact that candidates do not seem to learn the tests for ions for this Paper.

- (a) Candidates rarely mentioned layers of atoms in answering this question and tended to write generally about the 'properties being different in the alloy to those in the original metals' without being at all specific. Some candidates mentioned the fact that the atoms were different sizes but did not elaborate further and so could not gain the mark.
- (b)(i) Most candidates obtained the mark for 'blue' but a sizeably minority thought that a mixture of copper and zinc ions would be colourless, perhaps focussing on the zinc rather than the copper.
- (ii) Most candidates performed poorly on this part. Most candidates realised that copper hydroxide is blue but not all got the mark through lack of the observation that a precipitate is formed. Many were content to suggest that a white precipitate was also formed, forgetting that the solution was a mixture of zinc and copper hydroxides. The equations when attempted were poorly constructed. The major errors were (i) lack of balance of hydroxide ions on the left (ii) incorrect formulae of zinc and copper hydroxides, most often CuOH , ZnOH (iii) ions appearing on one side only (iv) sodium appearing on the right hand side. There were a lot of vague comments about displacement reactions which were not relevant. Many candidates failed to identify the precipitates.
- (c)(i) Fewer than half the candidates identified zinc chloride and copper as the products of the reaction of brass with dilute hydrochloric acid. Many thought that copper chloride was formed
- (ii) Very few candidates wrote the correct ionic equation for the reaction of zinc with acid. The main errors were: (i) to put zinc ions on the left and zinc on the right (ii) to write an equation in which ions appeared on one side only.

Question B11

This question was tackled by the majority of the candidates and most obtained at least half the marks available.

- (a) Most candidates identified the ester link. The commonest error was to write that this was a lipid.
- (b)(i) Fewer candidates identified amino acids as the monomers produced by hydrolysis of proteins. The most common error was to 'divide an amino acid up' and suggest that amines and carboxylic acids were the monomers. This probably arises from the idea that nylon can be made from these two basic units. This was given credence by the fact that some candidates wrote diamines and dicarboxylic acids as their answer.
- (ii) 'Hydrolysed' or 'breaks the amide link' was the often seen correct response. However, some candidates wrote vaguely and at length about chains breaking up without using any words chemically related to this hydrolysis.
- (c)(i) Over half the candidates could draw the correct structure of poly(chloroethene) but many lost the mark for not showing the 'extension bonds' or failing to put in the 'n' if they just showed a single unit.
- (ii) Very few candidates could explain why poly(chloroethene) has a low melting point. The majority realised that weak bonds/forces were involved but then went on to write about weak covalent bonds or weak bonds between the atoms rather than focussing on weak forces between the molecules. A number of candidates wrote, incorrectly, that there were weak bonds between the monomers.
- (iii) This part of the question was generally well answered with most candidates knowing the reaction between bromine and alkenes and the reason why bromine does not react readily with poly(chloroethene). Many candidates tended to give answers which were unnecessarily wordy in the description of the 'bromine water' test, giving equations as well as a full explanation of the chemistry involved. This was not necessary because this part of the question stated 'what will you observe...'. Those candidates who failed to identify the type of reaction as being an addition reaction, suggested incorrectly that it was a substitution reaction. A large number of candidates suggested, incorrectly, that the reason why bromine does not react readily with poly(chloroethene) was related to the reactivity of the chlorine atom in that chlorine was more reactive than bromine and therefore could not be substituted.
- (d) This part was generally well answered, nearly all candidates scoring at least one of the two marks. Practically all candidates knew that plastics such as poly(chloroethene) are not biodegradable but fewer scored a second mark because of rather vague statements such as 'form polluting fumes on burning' or statements about landfill sites such as 'they are put in landfill sites' which do not go far enough to address the litter problem or problems with filling up the landfill sites.

CHEMISTRY

Paper 5070/03

Paper 3 – Practical Test

General comments

The overall standard was encouraging with many candidates demonstrating a good understanding of both qualitative and quantitative techniques.

Comments on specific questions

Question 1

- (a) The titration was generally well done, with many candidates scoring full, or nearly full marks. Iodine/thiosulphate titrations are relatively complex and most candidates were able to obtain a good set of results. 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.

It is clear that a few candidates 'alter' their results at a late stage to 'improve' them. This often leads to candidates losing marks. It is always advisable to record results as soon as possible and to have confidence in their accuracy.

- (b) Candidates were required to use their titration results to calculate the concentration of the oxidising agent, **X**, in solution **P**. Most candidates were able to do this successfully and there were only a few examples of candidates inverting the volume ratio. A few more inverted the mole ratio and therefore obtained an answer that was four times too large.

Answers were required to three significant figures and this caused some problems. There is considerable confusion over the difference between three significant figures and three decimal places.

- (c) Having obtained a value for the concentration, candidates needed to use this to calculate the relative molecular mass of **X** by dividing 1.70 by their concentration. Answers were again required to three significant figures. A significant number of candidates obtained final values which were clearly impossible i.e. less than one, but there was little evidence of candidates looking back through their work to spot the original error.

Question 2

This was a relatively complex exercise and many candidates found it difficult to make all the relevant observations. Marks were usually lost for incomplete rather than inaccurate observations. It was not necessary to make all the observations to score full marks. Despite the instructions, candidates continue to test for gases and then not name them or name the gas without any relevant test.

Solid **R** was manganese(IV) oxide and solution **S** was manganese(II) sulphate.

Test 1

When hydrogen peroxide is added to **R**, there is considerable effervescence and the oxygen produced relights a glowing splint. Some candidates noticed that the splint relit with a 'pop', but this is still the test for oxygen. Hydrogen 'pops' with a **lit** splint.

The reaction is very exothermic and the test-tube gets hot and this is a valid 'observation'. Despite prolonged reaction there is no sign of **R** changing.

Test 2

When **R** is heated with concentrated hydrochloric acid, chlorine is produced and this bleaches litmus paper. Smell is not an acceptable test for chlorine. The mixture effervesces and some **R** dissolves to give a brown solution. It is not always easy to identify the colour of this solution and a range of colours was allowed.

Test 3

With aqueous sodium hydroxide, **S** gives a precipitate which is very pale brown. Acceptable colours had to be browner than white but whiter than brown. The precipitate is not white, nor is it red/brown. The precipitate does not dissolve in excess but it does darken in colour when left exposed to the air. The colour changes here and later apply to the solid not to any solution.

When hydrogen peroxide is then added, the precipitate becomes much darker (black) and there is considerable effervescence. Oxygen is again produced and should have been tested for.

Test 4

There is no reaction with aqueous silver nitrate and nitric acid. Candidates should be aware that 'negative' tests will occasionally be set. A significant number think that all tests must be positive and therefore recorded a 'white precipitate' for Test 4.

Test 5

The addition of aqueous barium nitrate to **S** produces a white precipitate which is insoluble in dilute nitric acid. A disappointing large number of candidates talked of the solution turning 'milky' or white. Such a change always means that a precipitate has been formed and this is how it should be described.

Test 6

When **S** is added to acidified potassium manganate (VII), a brown precipitate is formed. A number of candidates described this as a 'brown solution' which gained some credit. In experiments like this, allowing the mixture to stand usually makes it easier to see if a solid has been formed and its colour.

Conclusions

In **Test 1**, despite considerable reaction **R** does not appear to change suggesting that **R** is acting as a catalyst. The formation of chlorine in **Test 2** proves that **R** is now acting as an oxidising agent. With barium nitrate, **S** gives a white precipitate this, plus the lack of reaction with silver nitrate, confirms that **S** is a sulphate.

CHEMISTRY

Paper 5070/04

Alternative to Practical Chemistry

General comments

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

Skills include 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.

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.

Comments on individual questions

Question 1

The correct diagram is A, showing the bottom of the liquid meniscus on the 20 cm³ line.

Question 2

The first part of this question involves the electrolysis of water.

- (a) The addition of sulphuric acid is to increase the rate of electrolysis or improve the conductivity of water. Answers suggesting that water is not an electrolyte on its own were not acceptable.

The two gases produced are oxygen at X, and hydrogen at Y.

Each gas should have a correct test i.e. relights a glowing splint for oxygen and 'pops' in a flame for hydrogen. Answers in which the gases were reversed could still score the test mark so long as the tests were correct.

- (b) Twice as much hydrogen (Y) as oxygen (X) is produced.
- (c) Chlorine may be used to sterilise water. The gas may be tested by the bleaching of litmus.
- (d) There are several observations which candidates may suggest including sodium reacting, reacting violently, dissolving, or moving around the surface, and a gas given off.

Iron has no reaction with water but answers suggesting that rusting may occur were acceptable so long as the time factor was mentioned.

Question 3

This question involves the calculation of masses of precipitate produced in reactions. Candidates decide which of the two reactants will be in excess in each reaction.

- (a) The colour of the precipitate is cream or pale yellow and it may be removed by filtration. Although the colour of the bromide was not well known it may be deduced from the colours of the chloride (white) and the iodide (yellow).
- (b) The moles of silver nitrate and sodium bromide are 0.045 and 0.500 respectively.
- (c) The sodium bromide is in excess thus the mass of silver bromide produced is $0.045 \times 188 = 8.46$ g.
- (d) In the second experiment the moles of silver nitrate and sodium bromide are 0.060 and 0.050, silver nitrate being in excess. This produces $0.050 \times 188 = 9.40$ g of silver bromide.

Questions 4 to 8

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

Question 9

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

- (a) Potassium manganate(VII) does not react with iron(III) ions as iron(III) cannot be oxidised further. Similar answers such as iron(III) is also an oxidising agent or iron(III) has reached its maximum valency or oxidation state, are acceptable.
- (b) The mass of R is 6.08 g and the solution was measured out using
- (c) A pipette.
- (d) Acceptable colour changes are colourless, green or pale yellow to purple or pink.
- (e) Most candidates read the burette diagrams correctly and deduced the correct mean value to be used in the subsequent calculations. Candidates who read the diagrams incorrectly should choose the closest two volumes from their values, not necessarily the second and third. Failure to do so is penalised. The correct mean value is 25.7 cm^3 .

Correct answers to the calculations are

- (f) 0.000514 moles (g) 0.00257 (h) 0.0257 (i) 3.91 g (j) 64.25%.

Any incorrect answer may be used in subsequent parts of the calculation and marks gained accordingly.

Question 10

Correct answers to this analysis question are:

- (a) Colourless solution. Any mention of precipitates, solid or substances lost the mark.
- (b) and (c). Correct observations to each test are a white precipitate, soluble in excess.
- (c) The test for the iodide ion is the addition of dilute nitric acid followed by either, aqueous lead or silver nitrate, which gives a yellow precipitate. The correct formula for zinc iodide is ZnI_2 .

Question 11

Candidates were asked to plot pH values on the grid and to connect the points with a smooth curve. The majority of candidates completed this exercise accurately and connected the points as required. Candidates were also asked to extend the graph to find the pH of 25.0 cm³ of 0.100 mol/dm³ sodium hydroxide. This was achieved by continuing the graph back to the y-axis giving a pH value of 13.8. Candidates, whose extension did not follow their original line or intentionally finished at a pH of 14, did not gain the mark.

- (d) The pH when 35.0 cm³ of acid was added was read from the candidate's graph.
- (e) The pH at the end-point is 7.0 and the candidate should then read the volume of added acid from their own graph. This should be 27.0 cm³. Many candidates suggested that the end-point pH was the point at which the line on the graph started its vertical descent. This was incorrect.
- (f) There are three scoring points to the process of producing good quality crystals. (i) Evaporate the solution to saturation, (ii) Allow the solution to stand and cool, (iii) Filter the crystals.

Candidates must state the purpose for heating the solution initially. A statement that the solution should be heated does not gain the mark, although the remaining two marks could still be gained. Heating to dryness loses all three marks as crystals would not be produced.

- (g) The equation should be used to deduce the mass of sodium sulphate produced. Molar mass of Na₂SO₄ (142) x 0.025 x 0.5 = 1.78 g.