CHEMISTRY

Paper 5070/01

Multiple Choice

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

General Comments

The questions on organic chemistry were answered very well and only one question on the rest of the paper, **Question 19**, proved unduly difficult.

Comments on Individual Questions

Question 12

The proton number of an atom is also the number of electrons in one atom of the element. Consequently, one method of obtaining the total number of electrons present in one molecule of carbon dioxide was to add together the proton number of carbon and the proton numbers of two atoms of oxygen.

Question 13

Magnesium is a metal, and oxygen a non-metal. At this level a generalisation is that a metal and a non-metal bond together by forming ions. Thus any mention of covalent bonding, by candidates guessing the answer, was most likely to be incorrect.

Question 14

Alternative **A** was more popular than the correct answer due to candidates assuming that sulphuric acid and sodium hydroxide react in the ratio of one mole to one mole.

Question 19

Over 50% of the candidates chose the incorrect alternative **C**. Ammonia was needed for both stages of the process, and from the equations it could be deduced that 34 g of ammonia were needed to produce 80 g of ammonium nitrate. Thus 17 g of ammonia would only produce 40 g of ammonium nitrate. All that remained was to work in tonnes rather than grams.

Question 21

Three of the four options increased the rate of the reaction and were almost equally popular answers. However, only increasing the pressure would increase both the rate and the yield of the reaction. Candidates must ensure that they read the entire stem of a question.

Question 25

The essential change when zinc is formed from zinc sulphide is:

$$Zn^{2+} + 2e^{-} = Zn\text{, which is reduction.}$$

The zinc has not lost/gained oxygen or hydrogen but the definitions of oxidation and reduction involving electron transfer can be applied to the reaction.

Question 26

Guessing was prevalent in the answers to this question. Copper is below hydrogen in the reactivity series and does not react with dilute sulphuric acid, although this was a popular answer to the question.

CHEMISTRY

Paper 5070/02

Theory

General comments

Many candidates tackled this paper well but a large number had difficulty coping with the questions which were posed in unfamiliar contexts requiring skills of information handling and problem solving e.g. **Questions A2 (a)**, **(b)** and **(c)**, **A5(b)(ii)** and **A6(c)**. Good answers were seen in **Questions 1** and **A5** (apart from **part (b)(ii)**. Few candidates, however, scored full marks on the other questions, generally losing marks on those parts which required a degree of explanation and continuous prose. The rubric was generally well interpreted. The majority of candidates attempted most parts of each question and most attempted three questions in **part B**. Most of the candidates who scored well on ***section A*** maintained or even improved their standard in ***section B***. Indeed, some candidates who did not score very well on ***section A*** gained a considerable number of their marks from the ***section B*** questions. It is encouraging to note that most candidates did not give unnecessarily lengthy answers to some of the questions involving free response. **Questions A5(b)(ii)**, **A6(c)** and **B8(a)(i)**, however, did elicit rather garbled and over complicated responses in some cases. In extended questions, some candidates disadvantaged themselves either by not answering the question or by giving sloppy and non-specific responses. This was most apparent in **Question B8(a)**, where many candidates failed to respond to the word ‘describe’ and gave theoretical answers involving adsorption and solubility differences rather than practical descriptions. If a theoretical explanation had been required the word ‘explain’ would have been used. Candidates’ attention should be drawn to the meaning of the terms used in the ‘Glossary of Terms’ section of the Syllabus. 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 standard of English was generally good. In ***section B*** no one question seemed to be less popular than the others. Those who chose **Question B9**, however, tended to score lower marks relative to the other ***section B*** questions. 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 B8** and **B10**. As noted in previous Examiner Reports, many candidates were found to have a poor knowledge of practical procedures as evinced by relatively poor attempts at **Questions B8(a)** on chromatography. It was encouraging to note that many candidates were able to construct and balance symbol equations. A large number of candidates successfully balanced the complex equation in **A3(c)**. Many candidates, however had difficulty in balancing the electrons in **Question B9(b)(ii)** and in constructing an ionic equation in **Question B10**. It is very encouraging to note that most candidates performed well on the calculations and even many quite poor candidates acquitted themselves in calculations involving titrations, **A5(b)(iii)** and empirical formulae, **B8(c)**.

Comments on specific questions

Section A

Question A1

Many candidates obtained at least four of the six marks available. **Parts (i)** and **(iv)** were the parts most commonly answered incorrectly.

(i) Arsenic, As, was the commonest incorrect answer. This error arises from the common mistake of forgetting that hydrogen and helium are the first Period in the Periodic Table.

(ii) Although many candidates correctly identified helium as the gas found in balloons, a considerable number suggested that that other noble gases, especially argon, could be used. This presumably arises from candidates thinking that all noble gases have similar properties and therefore similar uses. Of the non-noble gases suggested, oxygen was most often seen.

(iii) Most candidates realised that chloride ions produced a white precipitate with silver nitrate but a variety of other answers were seen, the main incorrect ones being iodine and bromine.

(iv) Many candidates appeared not to understand that non-metals form negative ions. Consequently aluminium, boron and iron (iron III) were commonly seen incorrect answers.

(v) Many candidates knew the use of nickel as a catalyst in the hydrogenation of alkenes. Common errors included iron (by incorrect reference to the catalyst in the Haber Process) and silicon (sometimes seen as SiO_2). The latter presumably arose by muddling hydrogenation with cracking.

(vi) Although most candidates gave one of the correct responses, a large minority suggested nitrogen and sulphur. This incorrect answer presumably arose from a misreading of the question as 'two elements which react in the air to form acid rain', thus leaving out the essential word 'combine'.

Question A2

Most candidates scored fewer than half marks for this question, **parts (b)**, **(c)** and **(f)** being particularly poorly answered. Candidates should be encouraged to practise questions like this, which are about unfamiliar experiments. These will continue to be set to comply with the syllabus statements about applying knowledge 'in a reasoned and deductive manner to a novel situation'.

(a) Many candidates scored at least one mark for this section but others failed to write observations: the question clearly states 'what could be seen….': Answers such as 'carbon is formed' or the 'mass decreases' are not sufficient.

(b) Few candidates realised that the additional block was to ensure that the magnesium reacted with the carbon dioxide and not oxygen from the air. Many suggested incorrectly that 'the block prevents the gas escaping' or 'stops heat loss'.

(c) Many candidates lost the mark here because they just put the word 'temperature' rather than stating that the temperature was low.

(d) Although many candidates obtained the correct answer, 33.75, many lost a mark because they rounded up by too great an amount in the intermediate stage of the calculation. Candidates should be advised to only round up figures at the end of the calculation.

(e) Many candidates gained a mark for the correct calculation of moles of magnesium and moles of carbon dioxide, (0.25 and 0.1) but failed to capitalise on this by referring to the two to one ratios in the equation. A small number of candidates disadvantaged themselves by giving correct molar ratios but then suggesting that carbon dioxide was in excess. A significant number of candidates did not use the molar ratio in the equation correctly.

(f) This part was the least well done for this question. Many candidates suggested that energy was 'needed' (i.e. an input of energy) for both bond breaking and bond making. Candidates should be advised not to use the word 'need' but rather use the phrases 'taken in' and 'given out'. Another common misconception is to suggest that it is the number of bonds broken and made which is important. Incorrect answers such as 'more bonds are made than are broken' were not uncommon.

Question A3

This question was reasonably well done by most candidates and many made a good attempt at constructing the difficult equation in **part (c)(ii)**. Most candidates scored at least one mark for **part (a)** and the function of a catalyst was well known.

(a) Many candidates gave the correct answers methane and carbon dioxide. Those candidates who gained a single mark, usually chose methane (correct) and either carbon monoxide or sulphur dioxide (incorrect). Other common incorrect answers were nitrogen and ammonia.

(b) This was generally well answered. The commonest errors were (i) drawing a chain of five carbon atoms (ii) writing the formula for butanol rather than butanoic acid and (iii) drawing an incorrect carboxylic acid group by putting a hydrogen on the carboxyl carbon atom or putting a double bond in the incorrect place.

(c) (i) Most candidates could give a suitable definition of a catalyst. A minority failed to gain the mark by vague statements such as 'it alters the rate of a reaction' or 'it changes a reaction'. Catalysts speed up a reaction. The word has a Greek root meaning 'undoing' – in other words making something happen more easily. A substance which reduces the rate of a reaction is called an inhibitor.

(ii) Most candidates gained at least one mark for this part. Those who failed to score a mark at all generally either omitted the oxygen on the left hand side of the equation or added additional hydrocarbon species on the right. The commonest error was to balance the oxygen using 55 oxygen molecules rather than 53 (for doubled up formulae in the equation).

Question A4

This question was fairly well answered but surprisingly few candidates could write the empirical formula for antimony sulphide. Many candidates failed to write observations for the effect of phosphoric acid on aqueous sodium (see also comments on **Question 2(a)**). Most candidates, however, could write the balanced equation in **part (b)(i)**.

(a) Most candidates obtained at least one mark for this part. The explanation was invariably correct even if the oxidant and reductant had not been identified correctly. The commonest errors were (i) to suggest species on the right hand side of the equation (phosphorus(V) oxide and potassium chloride were often given) or to suggest that phosphorus was an oxidant.

(b) (i) Many candidates were able to write the correct equation. The commonest errors were (i) to add hydrogen to the right hand side of the equation and (ii) not to balance the meta-phosphoric acid.

(ii) Most candidates failed to give an observation for the reaction of phosphoric acid with sodium carbonate and were content to write answers such as 'carbon dioxide is given off'. Many compounded this error by writing about limewater even though this did not appear in the question. As stated in previous Examiner Reports, the word 'observation' in a question invites the candidates to write about what they could see, hear or feel and not the inferences from this. Another common error was to suggest that a white precipitate would form.

(c) This part was surprisingly badly done even by candidates scoring high marks overall. Candidates should be encouraged to count up each atom, ticking them off in pencil as they go in order to get the correct number of atoms. Following this they should cancel the atoms down to the simplest ratio. The commonest incorrect answers were SbS_3, Sb_4S_6 and Sb_3S_2.

Question A5

This question was generally fairly well answered. The Examiners were particularly impressed by how many candidates could do the calculation correctly in **part (b)(iii)**. **Parts (a)(i)** and **(b)(i)** were also done well. Many candidates however had little idea of how to tackle **part (b)(ii)**, a question which is couched in a context and which requires information handling and problem solving skills which are not just mathematical.

(a) (i) This part was generally well answered. A variety of incorrect answers were seen including redox, displacement and cracking.

(ii) Very few incorrect answers were seen. Nearly all candidates realised that calcium oxide was basic.

(b) (i) Many candidates could write the equation for the reaction of calcium oxide with water. Common errors included (i) putting hydrogen on the right – presumably thinking of the reaction of a reactive metal with water (ii) adding silicon dioxide on the right or left – perhaps through confusion with the reactions in a blast furnace and (iii) giving the incorrect formula CaOH for calcium hydroxide.

(ii) Few candidates used the equation to relate the pH changes to the reaction between calcium hydroxide and carbon dioxide. When a chemical reaction was mentioned it was often the wrong one – the reaction of calcium oxide with water being a particularly common incorrect example. Many candidates just thought that the outside of the beam was pH7 because there was a layer of water on it. Many failed to gain a mark because they just specified air reacting rather than carbon dioxide. A large number of candidates did not read the stem of the question properly and suggested that the centre of the beam was starting off neutral and then becoming alkaline by reaction with ‘the air’. A small but significant minority of candidates seemed not to know the word ‘beam’ and thought that the diagram related to a cross section of the soil even though the word concrete should have alerted them to this.

(iii) The calculation proved straightforward for many candidates and it is encouraging to see that even relatively poor candidates were able to gain some marks here. Many candidates were able to gain at least two marks. The molarity of the hydrochloric acid was usually correctly calculated but the division by 2 to get the moles of calcium hydroxide was often omitted. Many candidates relied on some sort of formula for calculating the concentration of calcium hydroxide 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 = 0.014(4) mol/dm^3)

Question A6

Few candidates scored more than half the marks available for this question. Most candidates gained their marks from **parts (a)(i)**, **(b)** and **(e)**. **Part (c)** proved to be a good discriminator for A grade candidates but a wide variety of incorrect answers were seen for the other parts of this question.

(a) (i) Nearly all the candidates gained the mark for knowing the use of chlorine in water treatment. Those who lost the mark usually wrote vague or incorrect statements such as ‘kills animals’ or ‘kills insects’.

(ii) Sulphur dioxide was the commonest correct answer written by candidates but this was rarely seen. Common incorrect suggestions were sulphuric acid, bromine, fluorine, oxygen and sulphur.

(b) This was generally well answered, the main errors being (i) failing to convert the double bond to a single bond and (ii) omitting the extension (continuation) bonds.

(c) Very few candidates scored even one mark for this question. Most candidates thought that the question was about qualitative analysis and simply gave answers such as ‘iron(III) produces a red-brown precipitate’ and aluminium oxide produces a white precipitate’. A few realised that there would be a difference in solubility but this was not always well expressed with the result that the mark most often gained was that for filtration. A not uncommon error was to suggest that the oxides could be separated either by electrolysis or using a blast furnace.

(d) Many candidates did not appreciate the reason for adding cryolite to the aluminium oxide. Common errors included (i) it acts as a catalyst and (ii) it has a high boiling point.

(e) This was generally well answered although some candidates disadvantaged themselves by suggesting that a layer of oxygen rather than oxide was present on the surface of the metal. The commonest errors were (i) to suggest that the aluminium was an unreactive metal (despite being told in the question that it was reactive!) (ii) to write rather vague statements such as ‘the layer slows down the reaction between the aluminium and the acid’ or (iii) to write about the fact that the acid in the food was weak rather than focussing on the aluminium (oxide).

Question B7

Of the **part B** questions, this was marginally the most popular. The diagram in **part (a)** was fairly well attempted and many candidates gained at least two of the marks available even if they failed to score many elsewhere in the question. Most candidates scored at least one mark for the questions in **part (c)** but on the whole these were badly answered with many candidates referring to rates of reaction and collision theory rather than aspects of equilibrium.

(a) Many candidates were able to draw an accurately and well labelled energy profile diagrams. Most realised that the energy level of the products was lower than that of the reactants and that the catalysed reaction curve fell below the uncatalysed one. The commonest errors were (i) to omit the enthalpy change or just write H on the diagram without showing any arrows and (ii) to muddle enthalpy change with activation energy. Two points should be noted for further examination sessions (1) candidates should ensure that the catalysed and uncatalysed lines start and finish at the same point and (2) two separate diagrams (rather than the one requested) can lead to Examiners failing to award the marks especially when different scales are used. Regarding the second point, Examiners will always try to award marks if the candidate has not strictly followed the instructions but has given clear information – in this case two diagrams side by side using the same scale.

(b) (i) Most candidates gained the mark for realising that fractional distillation is used to extract nitrogen from liquid air. Many, however, wrote several lines of explanation which was not necessary – only the words 'fractional distillation' were required.

(ii) Although many candidates realised that cracking was the method required, few gained the mark for describing the conditions needed. The commonest incorrect answers involved 'hydrogenation' or 'burning hydrocarbons'.

(c) (i) Many candidates realised that the yield of ammonia increased when the pressure increased but few gained the second mark for providing a correct explanation. All too often, the answers incorrectly revolved around ideas of reaction rates, often compounded by ideas about colliding molecules being thrown in for good measure. There were many vague answers such as 'equilibrium increases' or 'there is less reaction'.

(ii) This part was less well done than **part (i)**. Some candidates realised that the yield of ammonia decreased when the temperature increased but few gained the second mark for providing a correct explanation. Even when candidates wrote that the reaction was exothermic, it often appeared as a 'throwaway line' in the midst of incorrect ideas to do with reaction rates. Again, there were many vague answers such as 'equilibrium increases' or 'there is less reaction'.

Question B8

Many candidates scored well on this question especially in **parts (b)** and **(c)** but few scored full marks, **part (a)** proving to be a particular stumbling block. Many candidates, however, scored more than half marks. Most were able to calculate the empirical formula in **part (c)** but fewer were able to calculate the molecular formula.

(a) (i) Few candidates scored both marks for this comparatively straightforward question. This was largely due to: (1) Many candidates writing about theoretical aspects of chromatography rather than describing how chromatography is carried out in the laboratory (2) Writing vague statement which could be misinterpreted. For example: 'the paper was put into the solution' (where the solution mentioned previously had been the solution of pigment). Candidates who drew a labelled diagram scored more marks than those who just provided a written description. Candidates should be encouraged to draw labelled diagrams wherever possible to explain themselves, especially if they feel that they can not express themselves adequately in English. Examiners will always accept good annotated diagrams as an answer to this type of question.

(ii) This was fairly well answered by most candidates. The commonest errors were (i) to suggest the inverse ratio i.e. distance solvent moves/ distance pigment moves (or to imply this in words) and (ii) to write vague statements such as 'the distance from the start line to the end line'. The term end line is not acceptable – the solvent front/ line must be referenced.

(b) (i) At least two of the three deductions about **X** were often correct. The fact that **X** is a reducing agent was fairly well known. The commonest error was not to write about **X** but to write about the potassium manganate(VII). For example 'potassium manganate is an oxidising agent' did not gain a mark.

(ii) Most candidates realised that **X** was saturated or did not contain C=C bonds. A few candidates stated that it was not an alkene. But this was already clear from the question which stated that it was a carboxylic acid.

(iii) Most candidates correctly identified that the acid was weak, or at least weaker than hydrochloric acid. A minority of candidates failed to gain the mark because they merely stated that **X** was acidic.

(c) (i) Most candidates could deduce the empirical formula for **X** (CHO_2). The commonest error was to divide by the molecular masses of oxygen and hydrogen. Very few candidates divided by atomic numbers.

(ii) Fewer candidates provided the correct molecular formula ($C_2H_2O_4$) compared with the correct empirical formula. The main problem seemed to lie with those candidates who merely divided the molecular formula mass by the empirical formula mass and came up with the answer 2 and proceeded no further.

Question B9

Most candidates found this question quite demanding and scores of more than five out of ten were rare. The equation was rarely correct and the explanation of electrical conductivity of aqueous sodium chloride was often found wanting, electron flow being referred to rather than movement of ions. In **part (c)** very few candidates could suggest why a gas forms at the tip of the needle and even fewer could explain why the solution becomes alkaline.

(a) Most candidates realised that electrolysis involved breaking down a substance using an electric current. The commonest reasons for not gaining the mark were (i) failure to mention the (electric) current/electricity and (ii) statements implying that the substances were just separated by the electric current, thus making the process seem like electrophoresis.

(b) (i) Most candidates could identify all the ions present in the solution. A few candidates failed to mention the hydroxide ion or replaced this by oxide ions. A few failed to gain the mark because they wrote 'chlorine (ion)' instead of chloride ion.

(ii) This was unexpectedly poorly done even by candidates scoring high marks in general. The commonest error was to balance incorrectly by putting + $2e^-$ on the left hand side of the equation. Other errors included (i) putting the chloride ions on the right hand side of the equation and (ii) only balancing with one electron. Most candidates realised that chlorine was diatomic.

(iii) Few candidates could explain why hydrogen was formed at the tip of the needle. Those who realised that hydrogen was formed did not go the extra step and write about the hydrogen ions being converted to hydrogen molecules. Some candidates mentioned a decrease in hydrogen ions without mentioning that hydrogen gas is formed. Candidates who wrote an equation were likely to gain the mark. Although many candidates wrote about sodium ions and hydroxide ions remaining in solution, few went further to state that it is the hydroxide ions which are responsible for alkalinity.

(c) As had been commented on in previous Examiner reports, the conduction of electricity by ions in melts and aqueous solutions of salts is not well known. Many candidates suggested that electrons are responsible for the conduction. Even when they did realise that ions were responsible for the conduction, some candidates wrote vague statements which did not imply that the ions actually moved. The word move (or one similar) is necessary in order to gain the mark. Some candidates disadvantaged themselves by implying that there were free ions and that the electrons in these ions moved.

(d) (i) The conditions for ester formation were not well known. Although the mark scheme allowed a mark for 'heating' many candidates gave unreasonable temperatures i.e. 1000^oC and high pressure. When a catalyst was suggested, it was very often not correct – many suggested nickel.

(ii) Many candidates had difficulty in writing the formula of the ester correctly. However, it was interesting to note that quite a few candidates who scored quite low marks overall were able to write the formula correctly. The main errors were (i) to put the COO group the wrong way round (ii) to copy the lactic acid part incorrectly and (iii) to alter the OH group on the lactic acid.

Question B10

Although this seemed the most straightforward of the four **part B** questions, very few candidates scored more than seven of the ten marks available. **Parts (a)** and **(d)** were usually well answered, thought not as well as expected. Few candidates, however, gained more than a single mark for **parts (b)** and **(c)** together.

(a) Most candidates could identify the number and type of subatomic particles present. A common error was to omit the number of electrons. A considerable number of candidates failed to gain a mark because they stated that there were 72 and 78 subatomic particles (rather than neutrons). Less common errors included (i) adding up protons, neutrons and electrons to make 6 subatomic particles (ii) suggesting that there were 52 electrons rather than 53 and (iii) mentioning alpha, beta and gamma rays.

(b) The colour change to produce iodine was well known but few chose a suitable oxidising agent. Few candidates realised that they could relate this question to the displacement reactions of the halogens with halide ions. Chlorine and potassium manganate(VII) were the most commonly seen correct answers. Incorrect answers generally referred to metals.

(c) The ionic equation was very poorly done. Most candidates did not even put the correct species on the left or right of the equation. It was common to see zinc ions and iodide ions on the left of the equation and zinc and iodine on the right. Other common errors were (i) to write zinc as Zn_2 (ii) to write iodide ions as I_2^- and (iii) to write a mixture of ions and atoms on each side of the equation.

(d) (i) This was generally answered fairly well with only a minority of candidates including general metallic properties. A few candidates disadvantaged themselves by writing that transition elements are coloured metals or are coloured solutions without reference to their compounds. A larger than usual number of candidates appeared to think that transition elements have low melting and boiling points.

(ii) Most candidates calculated the formula of titanium(III) oxide correctly from the charges on the ions. Only a minority of candidates incorrectly suggested the formula TiO_2.

(iii) The equation was generally correctly written. Hardly any candidates gave incorrect formulae and only a few candidates balanced the equation incorrectly. The usual error was to put 2 in front of the HC*l* rather than 4.

CHEMISTRY

Paper 5070/03

Practical Test

General comments

The overall standard was variable and although many candidates were able to demonstrate significant practical skills, a 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 iodine/sodium thiosulphate titration was generally well done. These are the most difficult titrations candidates are likely to come across at this level and it was encouraging to see that many candidates were able to complete the exercise successfully with many scoring full, or nearly full marks. Full marks were awarded for recording two results within 0.2 cm^3 of the Supervisor's value and then for averaging two or more results which did not differ by more than 0.2 cm^3.

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

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

(c) The second part of the calculation proved to be much more difficult than expected. Solution **P** was made by adding sulphuric acid to 8.50 g of barium peroxide and diluting the final solution to 1.00 dm^3. Once the concentration of hydrogen peroxide had been calculated in **(b)** this is then equal to 8.50 divided by the relative formula mass of barium peroxide. Many candidates made no attempt at this part of the question or obtained answers which were less than 1 and therefore clearly wrong.

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 but 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 lost marks unnecessarily by omitting one of these statements. It was not necessary to make all the observations to score full marks.

Test 1 When aqueous barium nitrate is added to **R** (potassium chromium(III) sulphate), a white precipitate forms. Allowing the mixture to stand for a few minutes allows the precipitate to settle and makes it easier to see that the precipitate is white not green. However, candidates who reported a blue or green precipitate at this stage gained some credit. The precipitate does not dissolve in nitric acid and this later leads to the conclusion that **R** contains the sulphate ion.

Test 2 There is no reaction between **R** and silver nitrate and/or nitric acid. When carrying out any test, candidates should be encouraged to observe the reaction as it is taking place. In this case a colourless liquid is added to a blue/green solution and because there is no chemical reaction taking place the only correct observation is 'no change' or 'solution becomes (slightly) paler'. 'Turns (dark) green/blue' is not correct. Candidates need to recognise that not all tests will give positive results.

Test 3 The addition of a small amount of aqueous sodium hydroxide to **R** gives a green precipitate which redissolves with excess sodium hydroxide to give a green solution. Only a small number of candidates scored all three points with many missing the original precipitate. When hydrogen peroxide is added and the mixture warmed, it effervesces and produces oxygen which relights a glowing splint. In tests like this, candidates are expected to make the observation, 'the mixture effervesces', and then go on to test and name the gas. A high concentration of oxygen often causes a glowing splint to relight with a 'pop'. This does not mean that hydrogen is also produced. Hydrogen only 'pops' a lighted splint not a glowing one. The final solution is yellow.

Conclusion

The precipitate formed in Test 1, together with the lack of reaction in Test 2 confirms that **R** is a sulphate. Most candidates scored this mark, although a number gave a large range of positive ions.

Test 4 When aqueous sodium hydroxide is added to **S** (potassium dichromate(VI) the solution changes colour from orange to yellow. The addition of aqueous barium nitrate produces a precipitate which, when allowed to settle, is seen to be yellow. Most candidates scored these marks. The addition of nitric acid causes the precipitate to dissolve. The final colour of the resulting solution is difficult to describe and either yellow or orange was acceptable.

Test 5 There is no reaction between **S** and sulphuric acid but when hydrogen peroxide is added there is an immediate reaction. The solution turns purple or dark blue, not black, and it effervesces vigorously, producing oxygen. As the reaction takes place the solution slowly turns green. Many candidates noted the effervescence but failed to test for the gas.

Test 6 When a few drops of potassium iodide are added to the acidified solution of **S**, the mixture initially turns red/brown as iodine is produced but as the reaction proceeds the amount of iodine increases and the red/brown solution turns into a black/grey precipitate. Although most candidates made one of these observations, few made both.

Conclusion

Candidates were asked to suggest a property of transition elements shown by these tests and although transition elements do have high melting or boiling points these are not properties shown by the tests. The conversion of **R** to **S** (Test 3) and **S** to **R** (Test 5) suggests that transition elements can show different oxidation states and this was the expected answer. The vigorous production of oxygen, when hydrogen peroxide is added in Tests 3 and 5, also suggest that the transition elements are acting as catalysts in these reactions and this was also acceptable.

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.

Report on Individual Questions

Question 1

This experiment involves the removal of oxygen from air by its reaction with heated copper.

(a) (ii) The syringe shows that 64 cm^3 of nitrogen remains in the syringe. Thus, 16 cm^3 (20%) of oxygen is removed from the sample of air. Many candidates were uncertain as to which gas is initially removed and which gas remains.

(b) (i) and **(ii)** The correct equation is $2Cu + O_2 \rightarrow 2CuO$ and the colour of copper(II) oxide is black.

(c) 0.0025 (0.16/64) moles of copper are used and **(ii)**, using the equation, 0.00125 moles or **(iii)** 30 cm^3 of oxygen are required. Using the answer from **(a)(iii)**, 20% oxygen, 150 cm^3 of air are required to react with 0.0025 moles of copper. Although the **Question (c)(iii)** asked for the answer in cm^3 many candidates used m^3, but so long as this unit was stated no marks were lost.

Question 2

(a) (i) The colour change is orange to green when acidified potassium dichromate(VI) is used **(ii)** to oxidise the alcohol, **(iii)** sulphur dioxide, SO_2, would give a similar colour change and **(iv)** propanol.

(b) The product of the reaction is propyl propanoate, **(ii)** an ester, **(iii)** whose presence can be detected by its sweet or fruity smell. An incorrect named alcohol in **(a)(iv)** may be used in a consequently correctly named ester. The remainder of the question involves tests to compare the strengths of the two acids, sulphuric and propanoic.

(c) The correct colours of universal indicator in the acids are yellow (propanoic) and red (sulphuric).

(d) (i) On reaction with magnesium ribbon, both acids produce a gas or effervescence, **(ii)** the reaction with sulphuric acid being the faster.

(e) These tests indicate that sulphuric is a stronger acid than propanoic acid, not that it is more concentrated or reactive as stated by some candidates. Reference to degree of ionisation or formation of ions is acceptable.

Questions 3 to 7

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

Question 8

(a) 1.32 g of sodium carbonate was used in the experiment.

(b) (i) The relative formula mass of sodium carbonate is 106 which is then used to calculate the concentration of the solution to be used in the experiment, 1.32 g x 4/106 giving 0.0498 (0.05) moles/dm^3. Many candidates failed to realise that 1.32 g should be multiplied by 4 in the calculation of moles/dm^3. Any error in either **(a)** and/or **(b)(i)** may be used correctly in **(b)(ii)** and the remainder of the question.

(c) The colour change of the methyl orange is yellow to orange, pink or red.

(d) Candidates should recognise that volumetric analysis is a method by which unknown concentrations may be accurately determined. A titration of 2 cm^3 is too small for such a procedure and would introduce a large inaccuracy into the results. Any answer involving this suggestion was awarded the mark.

(e) Since the burette is to be refilled with a diluted acid solution it must first be washed out with water followed by the solution with which it is to be filled. An answer of hydrochloric acid is insufficient. Solution H, or the diluted acid, is the correct answer.
It should be noted that a large number of candidates gave good answers to both **parts (d)** and **(e)**.

(f) The correct titres are 23.7, 23.1 and 23.3 cm^3 giving a mean value of 23.2 cm^3. Incorrect burette readings give different titres but so long as the correct appropriate mean is chosen the remaining marks may be obtained.

The answers to the calculations are
(g) 0.00125, **(h)** 0.025, **(i)** 0.108, **(j)** 1.08 mol/dm^3.

(k) This proved to be a difficult question for many candidates. An alternative to diluting the acid is to increase the concentration of the sodium carbonate but very few candidates realised that the increase should be by a factor of 10.

Question 9

A well answered question with many candidates scoring full marks.

(a) On dissolving in water a colourless solution is produced. This solution is used for the subsequent tests.

(b) The observations suggest that the other two ions are Zn^{2+} and Al^{3+}, although Pb^{2+} was a common acceptable alternative. Any incorrect ion charge was penalised once only.

(c) To confirm the presence of Ca^{2+} ions the correct observation is no precipitate or a slight white precipitate. A statement of no reaction is not acceptable.

(d) A test for iodide ions involves the addition of dilute nitric acid and either aqueous silver or lead(II) nitrate. A yellow precipitate is seen.

Question 10

(a) (i) Candidates are required to read diagrams of a syringe and a thermometer and to complete a table of results. The final column of results shows the temperature changes resulting from each part of the experiment.
Two graphs should be drawn the first being the volume of hydrogen against A_r, the second, temperature change against A_r.
The first graph is a smooth curve which, on extrapolation, gives the volume of gas produced if strontium (A_r: 88) is used in the experiment.
The mark is awarded by assessing the candidate's accuracy in reading their own graph.

(c) (ii) Since the mass of metal used in each experiment is the same, the number of moles of each element decreases as A_r increases. Hence, the volume of hydrogen produced decreases with increasing A_r. Many candidates gave correct answers to this question.
The second graph shows four points joined by straight lines. Candidates should observe that the graph shows no uniformity and no relationship between temperature change and A_r and hence the temperature rise for strontium cannot be predicted.
One mark is awarded for accurately plotting all the points on the two graphs. As in previous examinations, points must be plotted to an accuracy of a half small square.

(f) Copper is not used in the experiment as it does not react with hydrochloric acid.