CHEMISTRY

Paper 5070/11
Multiple Choice 1

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

General Comments

The large majority of the questions worked well in providing the required success rate for the paper and a satisfactory discrimination between the candidates. Only one question, namely **Question 20**, proved to be very easy.

The questions which caused most difficulty were **Questions 13, 14, 27** and **36**.

Comments on Individual Questions

Question 13

This question's four alternatives were equally popular suggesting that a large proportion of the candidates were guessing. In comparing reaction 2 with reaction 1 two factors had to be considered; particle size and the mass of magnesium. The former factor produced an increase in rate and the latter produced only half the volume of hydrogen. Consequently the graphs in alternative D correctly represented the two reactions.

Question 14

The alternatives C and D were each chosen by approximately forty percent of the entry. Among the ideas being tested in this question were firstly that a catalyst does take part in a reaction and is unchanged at the end of a reaction. Secondly that a catalyst only speeds up a reaction but does not start the reaction.

Question 17

The responses to this question were very varied. The key to success in this question was the realisation that calcium sulfate is insoluble in water and would be prepared by a method involving precipitation. In general, precipitation reactions involve the mixing together of two solutions each of which contain one of the ions (the ions being different) in the insoluble product.

Question 22

From the proton numbers given it was possible, using the Periodic Table, to identify each of the four elements given in the question. Only one of the elements was a transition metal and a typical property of transition metals and their compounds is their ability to act as catalysts. Thus alternative C was the correct answer.

Question 26

Copper is below hydrogen in the reactivity series and therefore does not react with dilute hydrochloric acid. Thus alternative D which had a red-brown residue, copper, was the answer to the question.

Question 30

This was a recall question, straight from the syllabus. Although many correct answers were seen, a quarter of the entry incorrectly opted for alternative A. Candidates should remember that not every multiple choice question requires powers of deduction.

CHEMISTRY

Paper 5070/12
Multiple Choice 1

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

General Comments

A large number of questions had high success rates but nevertheless, the paper overall provided a satisfactory test of each candidate's ability. **Question 34** did not discriminate well between the candidates. Apart from **Question 34** all the questions performed well and showed good discrimination.

Comments on Individual Questions

Question 1

This question was solved by realising that hydrogen, in the list of gases, was the only gas less dense than air. Therefore the only gas which could be collected by the method shown in the question.

Question 16

Almost half the entry incorrectly suggested that a catalyst does not take part in a reaction. Catalysts do take part in reactions but are unchanged at the end of the reactions.

Question 17

As a general rule an insoluble salt e.g. calcium sulfate is formed by a precipitation reaction which involves the mixing together of solutions of two soluble salts. Only alternative B contained two soluble salts with all the other alternatives containing at least one insoluble salt.

Question 18

Titration as a method of forming salts can only be used for the preparation of soluble salts, since it is very difficult in a reaction involving the formation of an insoluble salt to determine when precipitation is complete.

Question 21

Sodium floats on water and therefore must have a density less than $1 g/cm^3$. The density values for the elements provided the quick method for identifying sodium.

Question 25 and Question 27

Unfortunately, to some extent these two questions overlapped and in both a failure to realise that copper is below hydrogen in the reactivity series was the downfall of many candidates. Due to its position in the reactivity series, copper does not react with either dilute hydrochloric or dilute sulfuric acid.

Question 33

Calcium carbonate undergoes decomposition on heating to form carbon dioxide and consequently many of the candidates mistakenly included calcium carbonate in their answer. The word burn was the key word in the question and calcium carbonate does not burn.

Question 36

Careful examination of alternative A reveals that it is not a carboxylic acid. However a significant number of candidates did fail to notice that the groups shown were not carboxyl groups.

CHEMISTRY

Paper 5070/21
Theory 2

General comments

This paper contained several questions with unfamiliar context which many candidates found challenging and a significant proportion of candidates left many part questions blank. There was little evidence that candidates did not have enough time to finish

Most candidates followed the rubric of the question paper and attempted just three questions from **section B**. A small proportion of candidates attempted all four questions from **section B** and then crossed out their answers to one of these questions.

Candidates tended to find the short answer questions much less challenging than those which required extended answers. Many candidates gave imprecise and vague extended answers. The candidates often did not use the command words and stem of the question to direct their answers.

Many candidates had difficulty with the calculations and often did not use the concept of molar quantities such as molar masses or molar volumes.

Comments on specific questions

Section A

Question A1

Most candidates scored at least half marks for this question. Candidates found **(a)** and **(b)** the most difficult.

(a) About one half of the candidates correctly recognised nickel. The two common incorrect answers were hydrogen or vanadium.

(b) About one half of the candidates correctly recognised zinc. Calcium was a common incorrect answer.

(c) Many candidates correctly recognised sulfur. Common incorrect answers included iron and vanadium.

(d) Many candidates correctly recognised hydrogen. Sulfur was the most common incorrect answer.

(e) Many candidates correctly identified chlorine. Iodine was the most common incorrect answer.

(f) Many candidates correctly identified calcium. Incorrect answers often included the metals such as iron, zinc or copper.

Question A2

Many candidates found this question challenging and only a small fraction of the candidates were able to score in excess of 6 marks for this question. A significant proportion of the candidates did not attempt **(d)** or **(e)**.

(a) Candidates found this question the least demanding in **Question 2**. A common misconception was to write an equation which showed the decomposition of hydrogen peroxide to give hydrogen and oxygen.

(b) Most candidates did not realise that there were more molecules per unit volume and candidates were more likely to be awarded a mark for stating there are more collisions in concentrated hydrogen peroxide. Many candidates just repeated the information in the question and did not attempt an explanation.

(c) Candidates found **(c)** slightly easier than **(b)**. Candidates were more likely to refer to particles moving faster or having more energy than refer to more successful collisions.

(d) Most candidates did not realise that the activation energy was lowered and an even smaller proportion of candidates mentioned the idea of an alternative route. A common misconception was to refer to the activation energy of the particles increasing.

(e) (i) Many candidates did not recognise that the total volume would remain constant at 95 cm^3. The most common answer was 238 cm^3.

(ii) Most candidates used a gas syringe but a small proportion of the candidates used a test tube or cylinder that was not graduated. Many of the drawings included a means of heating the aqueous hydrogen peroxide but this was ignored. Only a small proportion of the candidates failed to label the diagrams.

Question A3

A significant proportion of the candidates found this question very challenging and did not attempt the calculations in **(a)** and **(b)**.

(a) Some candidates did not fully appreciate the meaning of the command 'show' and as a result did not show all of the required working out. Typically these candidates calculated the mole ratio 1.01: 0.50: 2.02 but did not show how the correct formula was deduced from this ratio. Two common misconceptions were to use the atomic number rather than the relative atomic mass, or to divide the relative atomic mass by the percentage.

(b) (i) A significant proportion of the candidates could calculate the amount of Fe_2O_3 in moles. A common misconception was to give the answer 0.08 based on ten times the amount of KOH.

(ii) More candidates than in **(b)(i)** could calculate the amount of KOH used as 0.008. A small proportion of the candidates tried to work out the amount of moles using its M_r.

(iii) Candidates found this question very challenging and only a very small proportion of the candidates used the molar ratio in the equation to show that Fe_2O_3 was in excess. Many candidates just compared the actual amount in moles. Good answers often calculated the amount of Fe_2O_3 that was actually in excess.

(c) This was the least challenging question and candidates either referred to the change in oxidation state or the gain of electrons.

(d) Some candidates were able to deduce that K_2FeO_4 was an oxidising agent. A common misconception was to refer to the presence of a transition element.

Question A4

This was another challenging question. A significant proportion of the candidates did not attempt **(b)**.

(a) Almost all candidates were able to score at least one mark but only the most able scored all three marks. Typically candidates found the determination of the number of electrons and neutrons more difficult than the number of protons, atomic number and mass number.

(b) Only the most able candidates showed the electronic configurations of Na^+ and O^{2-}. A small proportion of candidates gave covalent structures and other candidates got the charge on the ions the wrong way around.

(c) This was a very challenging question and only a very small proportion of the candidates could explain that the ionic bonds were very strong and so lots of energy was needed to overcome them.

Common misconceptions included strong covalent bonds and strong forces between molecules. No candidate referred to the giant ionic structure of magnesium bromide.

(d) Candidates found this question slightly less challenging than **(c)** but only a small proportion could clearly refer to the lack of ions that could move. A significant proportion of the candidates referred to the lack of moving or delocalised electrons but this was not given credit.

Question A5

This question was found to be very challenging and in particular the advantages and disadvantages of recycling were often poorly expressed. Many of the part questions were not attempted.

(a) (i) Less than half of the candidates recognised addition polymerisation, some candidates stated condensation but a significant proportion of candidates did not attempt the question..

(ii) Many candidates left this question blank and others drew structures that were incorrect, typically either a polymer, or a monomer without a double bond.

(b) Many candidates referred to the recycling of mobile phones rather than of the substances used to make mobile phones. Other candidates focused on the disposal of materials rather than the recycling of materials. In **(i)** many candidates referred to land pollution without specifying what this meant. The unqualified cost of recycling was not sufficient in **(ii)**. Very few candidates appreciated that it would be difficult to sort out all the materials found in a mobile phone prior to recycling.

(c) Many candidates recognised that copper sulfate was used as the electrolyte in the purification of copper but fewer candidates stated the correct materials used in the electrodes.

(d) (i) Many candidates included free or delocalised electrons in their diagram but only a very small proportion of the candidates drew closely packed positive ions. A significant proportion of the candidates did not label the positive ion and left a circle with a positive sign, this was not given credit in the mark scheme because it could have been a proton. A fairly common misconception was to try to draw a 'dot-and-cross' diagram for metallic bonding.

(ii) Many candidates recognised the importance of mobile electrons with only a small proportion of candidates referring to free ions.

(e) (i) A significant proportion of candidates referred to electroplating iron but did not specify which metal was used. The most common correct answers were galvanising and the use of oil or grease. Surrounding iron with plastic was not sufficient to be awarded a mark.

(ii) Only a small proportion of candidates were able to give an adequate explanation for rust prevention. Often candidates repeated their method of rust prevention without offering an explanation. Candidates that used oil and grease found it easier to explain than those that used galvanising.

(iii) The knowledge of the protective layer of aluminium oxide was not well known.

Section B

Question B6

Of the **section B** questions this proved to be fairly popular but it rarely provided candidates with more than five out of the ten marks available. Although many candidates scored well in **(a)**, **(b)** and **(e)**, many candidates found the calculations in **(c)** and **(f)** very challenging.

(a) Many candidates recognised boiling point as the correct property.

(b) Many candidates could use the general formula for an alkane to deduce the formula for $C_{12}H_{26}$.

(c) Only a very small number of candidates were able to write the balanced equation to make nitrogen monoxide. The most common error was to write the formula of nitrogen as N rather than N_2 and oxygen as O rather than O_2. Only a small proportion of the candidates were able to use the mole concept to calculate the mass of nitrogen monoxide made. Error carried forward from an incorrect equation was allowed. A common misconception was to double the mass of nitrogen to give the mass of 110 kg.

(d) (i) Only a very small proportion of candidates could write the correct equation. Many candidates still included NO and NO_2 in the overall equation.

(ii) Although many candidates realised that the nitrogen monoxide was unchanged at the end of the reaction a common misconception was that nitrogen monoxide was not involved in the reaction.

(e) Many candidates could identify the substances oxidised and reduced, often explaining their answers in terms of the gain or loss of oxygen. Other candidates explained in terms of oxidation numbers. A common error was not to fully specify the substance, stating that nitrogen was reduced and carbon was oxidised.

(f) Only an extremely small proportion of candidates could do this calculation. Typically candidates did not account for the number of electrons in one molecule of nitrogen monoxide or they multiplied Avogadro's constant by 30, the relative formula mass.

Question B7

Of the **section B** questions, this proved to be the most popular. Many candidates could interpret the information given in the table however they found **(d)** much more demanding.

(a) Many candidates were able to name the alkyne as butyne.

(b) Although some candidates could draw the structure of propyne, other candidates drew structures with pentavalent carbon atoms or with two double bonds rather than a triple bond.

(c) (i) Over half of the candidates were able to make an acceptable estimate for the boiling point.

(ii) Most candidates could deduce the molecular formula as C_6H_{10}.

(d) (i) Most candidates were unable to explain why combustion is exothermic. Typically candidates referred to the energy needed to form bonds rather than the energy released. Candidates would be advised to answer the question as three bullet points.

- Bond breaking takes in energy.
- Bond forming releases energy.
- More energy is released than taken in.

(ii) Although a greater proportion of candidates could answer **(ii)** rather than **(i)** this was still a challenging question. A common error was to use the molar volume at stp rather than rtp to calculate the moles of ethyne. An error carried forward was allowed for this error. Other candidates just multiplied 1410 by 1000.

(e) (i) Many candidates found this question challenging and rarely could give a correct molecular formula.

(ii) Many candidates were not able to relate the test for unsaturation to the reaction of bromine with ethyne.

Question B8

This was the most unpopular question in **Section B** and also the most challenging.

(a) (i) Many candidates could not relate the exothermic nature of the reaction to the shift in the position of equilibrium.

(ii) Many candidates could not relate the change in the amount of moles of reactants with the amount in moles of products to the change in pressure. A significant proportion of candidates did not recognise that the products had more moles than the reactants.

(b) Most candidates did not convert the masses of ammonia and nitrogen monoxide into their amount in moles. Instead they calculated what percentage 100 tonnes was of 160 tonnes. Only the most able candidates could work out the mass of nitrogen monoxide that should have been made (176 tonnes) and then used it to calculate the percentage yield.

(c) (i) Only a small proportion of the candidates recognised that the salt would be prepared by titration and were able to describe the evaporation of the aqueous solution.

(ii) Most candidates found this question very challenging and there was very little evidence of candidates using the formulae of ammonium nitrate and steam to deduce the formula of **X** as N_2O. Common incorrect gases included N_2 and NO_2, other answers gave formulae containing nitrogen, oxygen and hydrogen.

Question B9

There was evidence that some candidates had run out of time and had left questions unanswered. Candidates found **(d)** and **(e)** particularly challenging.

(a) Many candidates referred to the decay of vegetation or from cows but a common misconception was to refer just to natural gas.

(b) Many candidates could give two consequences of an increase in global warming. The most popular responses were melting of the ice-caps, climate change or an increase in the sea-levels.

(c) Although many candidates were able to deduce that the percentage of atmospheric methane is increasing few candidates realised that the overall effect of methane global warming was greater than that of carbon dioxide. Some candidates had the misconception that the percentages of methane and of carbon dioxide were linked so that an increase in methane meant an increase in atmospheric carbon dioxide.

(d) Some candidates were able to draw a correct 'dot-and-cross' diagram but others did not include shared pairs of electrons.

(e) Candidates found this part question very challenging and only an extremely small number of candidates referred to weak intermolecular forces. Many candidates just focused on the fact that both molecules were covalent.

(f) Although some candidates could write the balanced equation, a significant proportion of candidates wrote hydrogen H rather than as H_2.

(g) The type of reaction was not well known by candidates and often displacement, redox or addition was quoted. Many candidates could give one correct product typically chloromethane but were unable to give another. Hydrogen was a common incorrect product given by candidates.

CHEMISTRY

Paper 5070/22

Theory 2

General comments

Many candidates tackled this paper well, especially in ***Section A***. Aspects of inorganic chemistry were generally well answered but as in previous years, questions involving organic reactions tended to create some problems for many candidates. Good answers were seen in **Questions A1, A2, A4** and **A5**. In general ***Section B*** questions were less well done than those in ***Section A***, the equilibrium **Question B9** proving most demanding of the latter.

Candidates often lost marks on questions which required a degree of explanation.

The rubric was generally well interpreted and the standard of written work was generally good. The majority of candidates attempted all parts of each question. A few candidates insisted on attempting all four questions in ***Section B***. It is not advisable to 'hedge ones bets' in this way since time is limited and it was apparent that some candidates who appeared to have rushed their work made rather basic errors.

Many who scored about 30 marks in ***Section A*** were unable to keep up their standard in ***Section B***. In both sections many candidates gave unnecessarily lengthy answers to some of the questions involving free response e.g. **Questions A3(c), (d)** and **(e), A4, B9(b)** and **B10(d)**. Candidates should be encouraged to note how many marks are available for the question in hand and write the number of points down equivalent to the number of marks available. As suggested in previous Principal Examiner Reports for Teachers, candidates would be advised to look at the detail in the marking schemes to satisfy themselves of the amount of writing required. The standard of English was generally good.

In ***Section B,*** **Question B10** was least popular but often scored better than the organic **Question, B9**.

Qualitative tests and general properties seemed better known than in previous sessions with many candidates successfully remembering the test for nitrates and zinc ions.

Many candidates disadvantaged themselves by writing too many points to questions requiring a specific number of answers. For example in **Question A2(c)** many wrote 'extra answers' which may have been incorrect e.g. the inclusion of the extra answer high melting point would negate one of the two correct answers previously given. This also proved a particular problem with **Question A5(c)(i)** where candidates listed a wide variety of supposed essential conditions for efficient fermentation, some correct and some incorrect.

Most candidates' knowledge of structure and properties in terms of atoms, ions and electrons was fairly good. It was encouraging to note that more candidates than usual seemed to be able to explain electrical conduction in graphite and sodium chloride by referring to the correct particles (electrons and ions respectively). It was also encouraging to note that many candidates had a reasonable knowledge of practical procedures as evinced by reasonably good attempts at describing how a soluble salt is prepared (**Question B10(a)(ii)** – at least compared with similar questions from previous sessions).

A considerable number of candidates had difficulty in writing symbol equations which were correctly balanced and even fewer could identify the correct state symbols for particular species. Ionic equations proved a stumbling block to many, very few candidates gaining the marks for **Question B9(d)(i)**. More candidates were able to write the ionic equation in **Question B10(c)(i)** but those who tried writing the equation to involve calcium ions usually failed to gain the mark.

It is encouraging to note that many candidates performed reasonably well on the calculations and even many relatively low scoring candidates were able to gain some marks. It was also encouraging to note that fewer candidates in this session used rounded up figures to continue with a calculation. Some, however, did not round up their answers correctly especially in **Question B10(b)(ii)**.

Comments on specific questions

Section A

Question A1

Many candidates scored at least 4 of the 5 marks available. Few scored fewer than 3 marks. Most parts were answered correctly, although **(c)** concerning the compound used to remove sulfur dioxide from flue gases, was not well known.

(a) This was generally correct, the commonest incorrect answer being methane. This reflects the general muddling up in candidates' minds of global warming with ozone depletion.

(b) This was almost invariably correct.

(c) About ½ the candidates realised that calcium carbonate could be used in flue gas desulfurisation. The most common incorrect answer was potassium dichromate. This presumably arose through a linking in the candidates' minds with the test for sulfur dioxide.

(d) Although many candidates correctly chose either barium sulfate or calcium carbonate, a large minority either chose sodium chloride or zinc sulfate. The former is surprising, since sodium chloride is such a common substance and is often part of questions involving ions or electrolysis (as in this Paper **Question A4(b)**).

(e) Most candidates correctly identified potassium dichromate. It was surprising that so many candidates suggested barium sulfate, especially in view of the fact that they should know that it is white from their knowledge of the test for sulfate ions.

(f) Although many candidates realised that ethene decolourised aqueous bromine, many suggested, incorrectly, that methane or propane would do this. The other common incorrect answer was sodium chloride, the candidates presumably thinking of displacement reactions but misunderstanding the relative reactivities of chlorine and bromine.

Question A2

Most candidates scored at least ⅔ of the marks available. Parts **(c)** and **(d)** proved most difficult, with only a minority of candidates being able to write a correct equation for the reaction of francium with water.

(a) Many candidates correctly deduced the number of outer electrons in francium to be 1. A common error was to suggest 8 electrons but some suggested numbers greater than 8.

(b) Most candidates gave perfectly correct answers. The commonest errors were (1) 223 for the number of protons, (2) 86 for the number of electrons and (3) incorrect number of neutrons – often 137.

(c) About half the candidates gained both marks but many failed to gain more than 1 mark because they wrote too many answers, some of which were incorrect. When predicting metallic properties it is best to stick to general properties shared by all metals such as conductivity of heat and electricity, malleability, ductility and lustre etc. Many candidates did themselves a disservice by suggesting that the melting point was high or that francium was very dense. A minority suggested chemical properties rather than physical properties.

(d) The equation for the reaction of francium with water was surprisingly badly done compared with similar questions in previous years for the reaction of alkali metals with water. Many candidates did not use the pattern of the reaction of alkali metals with water to construct their answer. Many thought that Fr_2O or FrO were formed. Those who realised that the hydroxide was formed often wrote the formula incorrectly as $Fr(OH)_2$ or did not balance the water.

Question A3

This question provided many candidates with their first real challenges on this Paper. The equation for the reaction of Zn with HC*l*, although of a similar difficulty as the equation in **Question A2(d)** proved to be more accessible to many candidates. Similar errors, however, were made. It was pleasing to note that more candidates than usual were able to identify the qualitative test for zinc ions. The rate of reaction questions in **(c)** and **(d)** were often poorly attempted, many candidates not answering the question in terms of particle collisions.

(a) The main errors in writing the equation were in identifying the correct formula of the product and in balancing the equation correctly. Zinc chloride was often written as ZnC*l* and the HC*l* was often not balanced. The other product was sometimes given as water rather than hydrogen. There was considerable confusion with the state symbols. The commonest errors here were to write HC*l* as a liquid and $ZnCl_2$ as a solid.

(b) (i) Most candidates deduced the mass loss to be due to the loss of gas. The commonest errors were (1) to ascribe the loss in mass to the zinc dissolving, (2) to 'hedge ones bets' and write 'the reactants dissolve and <u>also</u> the hydrogen is formed' and (3) to suggest that the wrong gas – usually carbon dioxide – is given off.

(ii) This question was well answered with many candidates drawing acceptable graph lines. Occasionally the lines did not start at the same point as the original or did not level out at the same mass. A few candidates ignored the rubric of the question and drew the line for the catalysed reaction on a separate set of axes at the bottom of the page. Since no direct comparison of the original line and the candidate's line was possible, it was not always possible to award credit for this.

(c) Most candidates found this part the most difficult in this question. Some candidates correctly deduced that the collision rate increased when the concentration increased (or decreased when concentration decreased) but very few made reference to the proximity of the reacting particles. This first marking point was most often achieved by those candidates who wrote about specific particles such as hydrogen ions being more concentrated when the solution was more concentrated. Few wrote about the particles themselves. Some candidates based their ideas about differences in ionisation of the acid, which is clearly incorrect.

(d) Although the majority of candidates gained a mark for relating smaller particle size to a larger surface area, few gained the second mark for the greater number of collisions. In many cases the 'collision' mark was not gained even though the candidate had gained the mark in **(c)**. It seems that many candidates think that the same answer cannot be given twice in an examination even though it is in a different context. A not inconsiderable number of candidates attributed the difference in rate being due to the zinc powder dissolving quicker.

(e) The context of the question seemed to confuse some of the candidates. Although about half scored both marks, many candidates thought that it was the solid zinc that should be reacting with the sodium hydroxide. Many started by describing the reaction with the acid and described a test for hydrogen as well (although not asked to do so). Many thought that the precipitate was sodium chloride. The mark scheme, however concentrated on the observations rather than on naming the products of the reaction. Many candidates obtained a mark for 'white precipitate' but fewer gained the 'dissolving' mark. Many did not obtain this second mark because it was not clear what was dissolving (it sometimes came before the precipitation in the sequence of writing). Only a few candidates suggested that the precipitate had a colour other than white.

Question A4

This question was well answered by most candidates, although **(d)** provided unexpected difficulties for many, some candidates clearly not being able to choose either a correct electrolyte fitting with their choice of electrolysis use or a correct equation following from the electrolyte chosen. The explanation of electrical conduction in graphite and in an ionic solution was better executed than in previous years.

(a) Whilst many candidates could explain why graphite conducts electricity but diamond does not, a large minority suggested that moving atoms or ions were involved. This was often accompanied by confused statements about the movement of the layers in graphite or emphasis on structure. A considerable number thought that graphite was an ionic structure. A greater number of candidates than usual took the trouble to compare the structures.

(b) About two thirds of the candidates obtained this mark. A minority of candidates ascribed the difference in conductivity to delocalised or localised electrons, atoms or molecules rather than ions. A number also claimed that solid sodium chloride is non-ionic and that the ions form on dissolving in water. It is encouraging to note that a greater number of candidates than usual took the trouble to compare solid and aqueous sodium chloride and not just concentrate on one of them.

(c) Many correctly-completed tables were seen. Common errors included (1) bromide in place of bromine, (2) sulfate in place of either oxygen or hydrogen, (3) reversing lead and bromine and (4) writing lead(II) instead of lead. Hydrogen was the commonest correct answer (for the ion at the cathode in dilute sulfuric acid).

(d) The candidates most likely to gain all three marks chose the purification of copper as their use. Candidates choosing the extraction of aluminium only occasionally gained the mark either for the electrolyte or for the equation. Those who chose electroplating often caused difficulties for themselves by selecting an unsuitable electrolyte or selecting a plating material for which they did not know the correct charge on the metal ion used in the electrolyte e.g. Au^{2+} and Ag^{2+} were often seen. Other common errors included (1) choosing an element such as copper or graphite as the electrolyte, (2) writing anode reactions in place of cathode reactions and (3) incorrect balancing of the electrons in the equation for the cathode reaction.

Question A5

This question was fairly well answered by most candidates although few gave credible answers to **5(c)(ii)**. Parts **(b)(i)** and **(e)** proved to be very straightforward with most candidates getting these marks.

(a) Although many candidates realised that the reaction involved cracking, a variety of other answers were seen. Addition was a commonly seen error. Hydrolysis and fermentation were other common incorrect answers.

(b) (i) Most candidates gained the mark for the correct equation which did not involve balancing. Common errors were to show carbon dioxide or hydrogen as additional products. A few candidates wrote steam over the arrow rather than showing this as a reactant.

(ii) Most candidates gained this mark. Common errors were to suggest ethanol or butanoic acid.

(c) (i) Many candidates did not see the significance of the word ‘efficient’ in the question and gave conditions such as low temperature or 20°C rather than selecting slightly higher temperatures. A not insignificant number disregarded the reaction as being naturally occurring and selected temperatures of 300 or 400°C. Yeast was often given as an answer for the catalyst but many just suggested ‘catalyst’ or even inorganic or organic catalysts such as phosphoric acid. A significant number of candidates lost marks because they wrote too much and included statements which conflicted with marking points in the mark scheme. For example the candidate who wrote ‘yeast and anaerobic respiration in an acidic pH’ could only get one mark because the value of the pH was incorrect. Some candidates thought that bacteria were involved in producing ethanol. (Although they are involved in some fermentations, these tend to produce acids or higher alcohols rather than ethanol.) Many wrote vague statements about optimum temperature and pH so could not gain a mark.

(ii) Very few candidates gained this mark. Common errors included (1) it is cheaper, (2) the product is purer, (3) the raw materials are cheaper and (4) better for making alcohol at home.

(d) This was well answered in general but some candidates failed to gain a mark through suggesting the use of drying agents or suggesting the vague answer 'evaporation'.

(e) The test for carbon dioxide was very well known. Few candidates failed to gain this mark.

Question A6

Analysis of the results of previous examinations have shown that many candidates find questions about polymerisation difficult. This question highlighted some of the difficulties candidates have in this field. Parts **(a)(i)** and **(a)(iii)** posed problems for many candidates.

(a) (i) Many candidates did not read the stem of the question carefully enough or did not realise what is meant by type of polymer. Many wrote answers referring to the name of the polymer rather than its type. Others suggested incorrect answers such as condensation polymer or polyester. Quite a few candidates left this part blank.

(ii) About ½ the candidates could write the formula for butene. A variety of different ways of writing the monomer were seen. Common errors were (1) to write the formula for but-2-ene, (2) to omit the double bond, (3) to draw continuation bonds and (4) to write the formula for propene. This was usually seen with those candidates who opted to write a full displayed formula.

(iii) Fewer than ½ the candidates wrote a suitable definition for a saturated compound through lack of exactitude. It is not sufficient to write that it contains single bonds since this does not preclude the presence of double bonds as well. The words 'contains only single bonds' is important here – this has been commented on in previous Examiner Reports to Teachers. Most of those gaining the mark chose the route of 'does not contain double bonds'. Many made the mistake of thinking that a saturated compound contains a double bond. A significant number of candidates defined a hydrocarbon rather than saturated.

(b) This was not very well answered. About ½ the candidates suggested that the polymer was not biodegradable or unreactive / insoluble in water. Many, however, wrote very vague statements about the strong bonding ion the polymer or the fact that the polymer was saturated without going any further. Quite a few candidates made the mistake of writing that the polymer was biodegradable.

Question B7

This question was a good discriminator, parts **(b)(ii), (c)** and **(d)** being particularly challenging.

(a) Many candidates were unable to gain the mark here because they did not mention both nitrogen and water. Some explained for example that nitrogen was not polluting but omitted any mention of water. Candidates must realise that Examiners have to be told everything – there cannot be the assumption that some things are taken for granted. Many candidates did not gain the mark because they wrote rather vague answers such as 'the products are environmentally friendly' or 'not very harmful'. The latter suggests that they may cause some harm.

(b) This was poorly answered. Many candidates made the error of suggesting that energy is required to make bonds. This is either a case of not understanding the meaning of the word 'required' or writing too fast without thinking. A few candidates did give very good answers – these tended to be short and to the point. For example: 'more energy is released when bonds form than is required to break the bonds in the reactants'. Some candidates wrote about different bond strengths or different numbers of bonds formed or broken. Neither of these gained credit without further reference to energy changes as required by the stem of the question.

(c) (i) About half the candidates calculated the volume of oxygen correctly. Common errors included (1) using 30 as the molar mass of hydrazine, (2) dividing the final answer by 1000 and (3) dividing by 24 rather than multiplying. Of those who did not gain three marks, the commonest mark obtained was the implication of the 1:1 ratio of hydrazine to oxygen.

(ii) It was only a minority of candidates who appreciated that more liquid oxygen could be stored in a given space. It was very common to see answers which referred to the reactivity of gaseous oxygen compared with liquid oxygen or to its ability to 'escape' from the container.

(d) (i) Fewer than ¼ of the candidates gained the mark for the correct formula N_2H_5Cl. A very wide variety of errors were seen, the commonest of which were ammonium chloride or N_2H_4Cl. Many candidates omitted particular atoms altogether, especially the Cl atom.

(ii) This question was designed to discriminate between higher grades and many candidates who scored high marks overall successfully drew the correct dot and cross diagram. The commonest error was to draw a double bond between the nitrogen atoms. Some candidates lost a mark because they omitted two of the hydrogen atoms. Some of the diagrams were difficult to read because the candidates had not rubbed out their original diagrams well enough and redrawn then over their originals. Candidates should be advised to redraw their diagrams elsewhere on the space available if they make a mistake or, if they are unsure in the first place, to do a preparatory drawing on one of the blank pages.

Question B8

This question was generally the best answered of the ***Section B*** questions, many candidates scoring half marks. The empirical formula calculation in **(b)** was generally well done but many candidates had difficulty obtaining the second mark when drawing the structure of terylene **(d)(i)**.

(a) (i) Over ½ the candidates gained the mark for identifying butanoic acid. The commonest errors were to suggest but<u>e</u>noic acid or pentanoic acid. Ethanoic acid and butanol were occasionally seen.

(ii) Over ½ the candidates gained this mark. Common errors tended to involve the presence of too few or too many hydrogen atoms on the –COOH group. A few examples were seen of structures containing the wrong number of carbon atoms.

(iii) This was generally well answered. The main errors were to suggest C_4H_4O or C_2H_5O

(b) Many candidates could do the calculation. The main errors were (1) use of 32 for the atomic mass of oxygen or 2 for hydrogen and (2) incorrect rounding up from the first or second steps.

(c) (i) This was generally well answered. Those who did not gain the mark either suggested a carboxylic acid, an alcohol or a different ester.

(ii) Although many candidates gained this mark, some gave rather vague answers such as 'for glue' or 'for soap' (rather than the solvent in glue or the scent in soap). Some did not gain the mark because they just named an ester. The main error was to suggest clothing due to a failure to distinguish between the ester ethyl ethanoate and a polyester.

(d) (i) This was the least well done part of this question. Although many candidates gained a mark for the correct formulation of the ester linkage, fewer drew a correct structure for the polymer. Some disadvantaged themselves by writing both correct and incorrect ester linkages in the same structure - the omission of an O was not uncommon. Many did not gain any marks because they wrote a nylon structure or wrote the ester link as –COOH-. The second mark was often not gained because of the lack of continuation bonds. Candidates who wrote a simplified structure with brackets and an 'n' after the brackets often were unable to gain the second mark because their repeat unit was incorrect, often implying that 2 ester groups combine within the structure.

(ii) While many candidates correctly identified fat or lipid as an appropriate example, there were a significant number of incorrect answers such as nylon. Polyester and carbohydrate were seen.

Question B9

The candidates found this question to be the most difficult on the Paper. The candidates' grasp of equilibrium was poor and few could provide a balanced ionic equation in **(d)(i)**. It was noted that the calculation in **(c)** was generally done fairly well whilst the definition of redox in **(a)** was well known.

(a) Most candidates could explain the term redox. Some candidates, however, suggested that the term referred to either oxidation or reduction, not both. Some candidates only described one half of the term e.g. oxidation is loss of electrons.

(b) This question was very poorly done. A small proportion of candidates offered clear, concise and accurate explanations. The majority, however, did not understand the question and clearly had no idea of equilibrium. Many suggested that the reaction goes to the left and others just concentrated on the overall rate of reaction rather than the forward and back reactions. A large majority of candidates were content to give answers based on the kinetic theory. Many did not gain the mark for linking the decrease in colour to the decrease in the concentration of iodine. Many also were unable to link the endothermic nature of the reaction to the shift in equilibrium to the right.

(c) The calculation was, in general, well done with many candidates determining the correct mass. A significant number of candidates calculated the number of moles of hydrogen to be 45.3 rather than 22.65. Some rounded up the 22.65 to 22.7 and thus got incorrect answers. Candidates should be advised not to round up during a calculation unless asked to. Some candidates did not use the 1:2 ratio of hydrogen to hydrogen iodide in their calculation or used an incorrect M_r value for hydrogen iodide, 127 being seen quite often.

(d) (i) Very few candidates gained this mark. Of those candidates who attempted to write an appropriate ionic equation many failed because they either did not balance it or gave the iodide ions a 2- charge. Many candidates did not seem to know what an ionic equation is and merely tried to write a full symbol equation. Many tried to include nitrate ions leaving out the iodide or lead ions. The state symbol mark was not often obtained because the species in the equation were incorrect. Even those who gained a mark for the correct species often did not gain the state symbol mark because they either (1) thought that lead iodide was an aqueous solution despite the information in the stem of the question or (2) omitted one of the state symbols.

(ii) Many candidates deduced **X** to be a reducing agent. Common errors included (1) oxidising agent, (2) it is a base or (3) it dissolves to form an acidic solution

Question B10

Although this was the least popular question in ***Section B***, most candidates who attempted it obtained about half marks. Most parts were reasonably well attempted but the questions on ammonia loss from ammonium phosphate **(c)(ii)** and the method for producing a soluble salt, **(a)(ii)** posed some problems for many candidates.

(a) (i) Most candidates were unable to gain the mark here because they did not focus on the words acid, alkali and potassium chloride. Many wrote equations for the production of other salts – nitrates or even sulfates. Common errors included (1) trying to balance the equation when no balance was required, (2) writing the formula of potassium chloride as KCl_2 and (3) using potassium or a salt to react with the acid.

(ii) Many candidates did not appreciate the words 'essential details' in the stem of the question and wrote at length about the titration method. They then often forgot to write about the crystallisation, so were not awarded the second mark. The converse applied to a minority of candidates. Candidates should be reminded to look at the number of marks available for the question. If details of the titration procedure were required, the mark allocation may well have been 4 or 5 marks. In this case only two marks were required, one for a brief description of the method and one for forming the solid from a solution.

(b) (i) Although about ½ the candidates gained the mark for the correct formula of ammonium phosphate, a wide range of incorrect formulae were seen, NH_3PO_4 being the most common, despite the formula of the phosphate ion being provided.

(ii) Many candidates correctly calculated the % nitrogen from their suggested formula. Some, however, spoilt their answer by incorrect rounding down of the figures to 21.18. Many made errors in calculating the relative molecular mass or the relative mass of the nitrogen atoms.

(c) (i) Most candidates gained the mark by writing the neutralisation equation in terms of hydrogen plus hydroxide ions. Only one or two candidates were able to write the equation in terms of hydrogen and calcium ions. A wide variety of errors were seen including (1) use of incorrect formulae, (2) incorrect products such as Ca, Ca^+ or CaO and (3) unbalanced equations

(ii) Few candidates gained this mark. Common errors were (1) to suggest that the % nitrogen was greater in potassium nitrate and (2) that potassium was needed in the soil as well – although this is true, it does not answer the question in terms of <u>nitrogen content</u> of the soil.

(d) It was encouraging to note that many candidates had remembered the test for nitrate ions. The commonest error was to omit either the sodium hydroxide or aluminium foil. Quite a few candidates did not score because they replaced the sodium hydroxide with hydrochloric acid. A not inconsiderable number of candidates did not think about what the test was for and stated that they would add nitric acid and then sodium hydroxide and aluminium foil. Unfortunately the addition of nitric acid negates the point of the test.

CHEMISTRY

Paper 5070/31
Practical Test 3

General comments

The overall standard was good. Most of the candidates were well prepared for the paper and demonstrated capable practical skills in completing the quantitative and qualitative exercises. Supervisors are thanked for providing the required experimental data to enable assessment of the candidates' work.

Comments on specific questions

Question 1

(a) Plenty of the candidates scored full or nearly full marks with the acid/alkali titration, showing proficiency in both technique and the recording and processing of data.

Full marks were awarded for obtaining two results within 0.2 cm^3 of the Supervisor's value, and then for averaging two or more results that did not differ by more than 0.2 cm^3.

Teachers should continue to emphasise that, in all titration exercises, candidates should repeat the titration as many times as necessary, until they have obtained consistent results. These titres, i.e. best titration results, should be ticked and then averaged. While candidates generally followed this procedure, there were some who did not. It was disappointing to find marks being lost due to mistakes such as failing to tick any results, ticking only one result or, having correctly ticked the best results, averaging all the titres regardless of their consistency.

While there were relatively few who scored maximum marks in the questions that followed, most of the candidates sensibly attempted all the parts. The calculations were marked consequentially throughout, even when this led to improbable answers.

(b) The most common error was to calculate 7.5 as the answer, so ignoring the difference in the volume units of the alkali concentration and of the pipette.

(c) This was the most successfully answered part although a few candidates made it more difficult by calculating the mass of acid present in their average titre and then working out the concentration of the acid.

(d) As in **(b)** the most common error was to give an answer which was a 1000x greater.

(e) As long as the answer from **(b)** was divided by that from **(d)**, the mark was awarded. There were however some candidates who inverted the ratio and others who subtracted the two numbers.

(f) Few candidates obtained both marks but there were a number who scored one. Writing the reactants formulae in the proportions consistent with the answer to **(e)** was usually how the mark was secured. Candidates found it difficult to identify the formulae of the products and, consequently, could not complete the equation.

Question 2

Many candidates completed all the tests and carefully recorded numerous correct observations. Nevertheless, marks were lost for incomplete answers and inaccurate recording. When a gas is observed e.g. by the bubbling of a liquid, the gas should be tested and identified. When a liquid is added to a solid, it should be recorded whether the solid disappears or not e.g. if a precipitate remains or disappears when a solution is added. Teachers should continue to encourage candidates to make full use of the qualitative analysis notes supplied on the last page of the exam paper. The terminology and method of reporting provided are a model for the successful recording of observations.

It was not necessary to make all the observations to obtain full marks for this question.

R was sodium carbonate **S** was potassium iodide **T** was potassium dichromate(VI)

Solution **R**

Test 1 **(a)** There were many candidates who missed the bubbling that occurred when the acid was added to solution **R**. Indeed, few of those who did report the gas then went on to test it and not all those who successfully turned lime water milky, named the gas as carbon dioxide.

(b) There is no reaction between the hydrogen peroxide and the residue from **(a)** but a number reported gas evolved.

Test 2 and Test 3 In both tests a precipitate is produced in **(a)**, which disappears when the acid is added and the final solution is colourless. While the precipitate in **Test 3** is white, that in **Test 2** is not. Recording that the precipitate disappears was required to score a mark in each test - precipitate turns colourless is not acceptable. Clear can be used to indicate that a precipitate has disappeared e.g. the mixture goes clear but clear does not mean colourless.

Solution **S**

Test 1 When acid is added to solution **S**, there is no change observed but the addition of hydrogen peroxide to the mixture produces iodine. Any description of the solution as being red or brown or of a black solid was acceptable for iodine but red or brown precipitate or black solution was not.

Test 2 The addition of silver nitrate solution to solution **S** produces a yellow precipitate which remains when nitric acid is added. While many noted a precipitate was present in the final mixture in **(b)**, its colour was not always yellow and the result of adding silver nitrate was sometimes inaccurately recorded as solution turns yellow or milky solution formed.

Test 3 Most candidates correctly noted that no reaction took place on addition of either reagent.

Solution **T**

Test 1 While many candidates stated solution **T** turned orange on addition of acid, there were few who reported all the observations with the hydrogen peroxide. Precipitates of various colours were noted rather than the initial dark blue solution but the final product was generally and correctly described as a green solution. More candidates recorded bubbling here than in **(a)** with Solution **R** but, once again, not all went on to test and identify the gas. No credit can be obtained for naming a gas if it has not been identified by the correct chemical test. The noisy relighting of the glowing splint made some believe the gas was hydrogen.

Test 2 and Test 3 In both tests a precipitate is produced in **(a),** which disappears when the acid is added and the final solution is either yellow or orange. The precipitate formed in **Test 2** is red or brown and that in **Test 3** is yellow. The majority of candidates correctly reported the formation of the precipitates but a few did not get one or both of the solids to dissolve in the acid.

Conclusions

The most frequently awarded conclusion mark was for providing the formula of the anion, I^-, present in **S**.

Suggesting compound **T** contained a transition element was, perhaps surprisingly given the variety of colours seen in the tests, not commonly found.

The failure to identify carbon dioxide being produced by reaction of **R** with acid meant few candidates could justify that CO_3^{2-} was present in the solution.

CHEMISTRY

Paper 5070/32
Practical Test 3

General comments

The overall standard was good. Most of the candidates were well prepared for the paper and demonstrated capable practical skills in completing the quantitative and qualitative exercises. Supervisors are thanked for providing the required experimental data to enable assessment of the candidates' work.

Comments on specific questions

Question 1

(a) Plenty of the candidates scored full or nearly full marks with the acid/alkali titration, showing proficiency in both technique and the recording and processing of data.

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While there were relatively few who scored maximum marks in the questions that followed, most of the candidates sensibly attempted all the parts. The calculations were marked consequentially throughout, even when this led to improbable answers.

(b) The most common error was to calculate 7.5 as the answer, so ignoring the difference in the volume units of the alkali concentration and of the pipette.

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(d) As in **(b)** the most common error was to give an answer which was a 1000x greater.

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Question 2

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The failure to identify carbon dioxide being produced by reaction of **R** with acid meant few candidates could justify that CO_3^{2-} was present in the solution.

CHEMISTRY

Paper 5070/41

Alternative to Practical 4

General comments

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

Skills tested include recognition, use and calibration of chemical apparatus, 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.

Comments on specific questions

Question 1

(a) Aqueous ammonia is an alkaline solution and therefore turns litmus solution blue.

(b) Aqueous copper(II) sulfate is a blue solution.

(c) When aqueous ammonia is added to aqueous copper(II) sulfate a blue precipitate is formed which dissolves in excess ammonia forming a deep blue solution.

Question 2

(a) The pink solid is copper which is deposited at electrode **B**. This is because copper ions are positively charged and therefore move to the negative electrode.

(b) The gas formed is hydrogen. When testing for hydrogen a burning (not glowing) splint is used and a pop is heard.

(c) The gas formed is oxygen which relights a glowing splint.

In **(b)** and **(c)** credit was not given if the gases were given at the wrong electrodes.

As sulfate ions were present in the solution a correct test for sulfur dioxide was also given credit.

(d) During the electrolysis the colour changes from blue to colourless as the copper ions are removed from the solution.

Question 3

(a) The mass of iron(II) sulfate crystals used in the experiment is 3.85 g.

(b) (i) When the crystals lose their water of crystallisation they are described as anhydrous. Dehydrated was also accepted.

(ii) The mass of iron(II) sulfate which remained after heating is 2.30 g.

(iii) The mass of water lost from the crystals is 1.55 g.

Errors in **(a)** and **(b)** can be carried forward and if used correctly this mark can be gained. This applies throughout the paper to all questions where previous incorrect answers are used.

(c) The relative formula masses of iron(II) sulfate and water are 152 and 18. Both answers are required for the mark.

(d) 0.015 moles of iron(II) sulfate remained after heating.
0.086 moles of water were lost during heating.

Candidates who gave their answers to only one significant figure did not receive credit.

(e) The value of **x** is 5.7 and the formula is $FeSO_4.6H_2O$.

To score the first mark 5.7 had to appear on the paper although it could then be rounded up to 6 on the answer line.

Questions 4 to 6

Correct answers to the multiple choice questions are **(c)**, **(b)**, **(c)**.

Question 7

There are two scoring points. The graph should be steeper than the given line because the acid is more concentrated and the horizontal line should be at twice the volume of gas than the given line because there are twice as many moles of acid present. Most candidates scored the first point only.

Question 8

(a) The colour change of phenolphthalein was from pink to colourless. These colours were given in the question and no others were accepted.

(b) The three titres are 26.5 (or 26.6), 25.8 and 26.0. As usual when errors occur in reading the burette diagrams or subtracting the volumes the mean must be taken from the closest two titres. A common error was to use all three titres in calculating the mean.

Answers to calculations are:

(c) 0.0025

(d) 0.0025

(e) 0.0965 (0.096 and 0.097 were both accepted)

(f) 88

As before, errors may be carried forward. This also applies to **(g)** and **(h)**.

(g) The value of n is 3. It is obtained by subtracting 46 from the answer to **(f)** and dividing by 14. This makes the formula of the acid $C_3H_7CO_2H$.

(h) Carboxylic acids react with alcohols in the presence of sulfuric acid to produce esters or alkanoates. The formula for **T** is $C_3H_7COOC_2H_5$. No credit was given for other homologous series based on an incorrect formula for **T**.

Question 9

This question involves the analysis of zinc chloride.

(a) A colourless solution is formed as transition metal ions are not present.

(b) Solutions containing aluminium or zinc ions produce a white precipitate when aqueous sodium hydroxide is added. The precipitate is soluble in excess sodium hydroxide.

(c) When aqueous ammonia is added to a solution containing zinc ions a white precipitate is formed. This precipitate is soluble in excess aqueous ammonia.

(d) Chloride ions are confirmed by adding nitric acid and aqueous silver nitrate. A white precipitate is formed. No marks could be obtained if silver nitrate was not used. The use of acidified silver nitrate lost 1 mark but if hydrochloric acid was used only the white precipitate mark was given.

Question 10

(a) Candidates are asked to read the thermometers and complete the table. The temperatures are 27, 31 and 32.

(b) The results are plotted on the graph. Candidates are given credit for plotting the points accurately and joining them with two intersecting straight lines. Most candidates scored well.

(c) The answers are read from the candidate's graph. If the graph is correctly drawn the answers are 33.8 and 22.

(d) The concentration of the sulfuric acid was 0.45 mol/dm^3. This is based on a correct mole ratio in **(i)**. Marks could still be obtained for a calculation based on an incorrect equation.

(e) Most candidates gained credit for stating that the reaction had finished but failed to state that the temperature decreased due to the addition of the cooler sulfuric acid.

CHEMISTRY

Paper 5070/42
Alternative to Practical 4

General Comments

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

Skills tested include recognition, use and calibration of chemical apparatus, 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

(a) The apparatus labelled **A** is a gas syringe which contains 72 cm^3 of carbon dioxide (answer to **(c)**).

(b) It can be positively tested by passing the gas through lime water which turns white or milky.

The correct answers to the remaining parts of the question are:

(d) 0.003 moles

(e)(i) 0.003 moles

(e)(ii) 100

(e)(iii) 0.3 g

(f) 85.7 (86) cm^3

A large majority of candidates answered this question well, the only part causing any difficulty was **(f)**.

Question 2

(a) Zinc is a shiny, silver, metallic or grey solid and aqueous copper(II) sulfate is a blue solution or liquid. In the latter case the word solution or liquid must be mentioned.

Candidates who are unsure of the colour of zinc suggest mixed colours such as silver blue or blue grey. No credit is given in such cases.

(b)(i) A rise in temperature of the solution or the solution gets warm suggests that the reaction is exothermic. A 'definition answer' for exothermic such as heat is evolved or released is not sufficient to gain the mark.

(b)(ii) The red solid is copper. Candidates are asked to name the solid thus answers such as Cu(II) or Cu are not acceptable.

(c) Two other observable changes include zinc dissolves, reacts or disappears, the blue colour of the solution fades or disappears, and a gas evolves.

(d) (i) The equation for the reaction is

$$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$$

(ii) The reaction is a redox, reduction and/or oxidation or displacement.

Questions 3 to 7

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

Question 8

(a) A pipette is used to transfer 25 cm^3 of liquid into the conical flask.

(b) The colour change on addition of the indicator is yellow to orange, pink or red at the end-point.

(c) The three correct titres are: 22.8, 22.2 and 22.4 cm^3, the mean being 22.3 cm^3 which is taken from the second and third titres. In cases where one or more of the titres is incorrect candidates must choose and indicate with a tick the closest two titres in calculating the mean.

The answers to the calculations are **(d)** 0.001 moles **(e)** 0.002 moles **(f)** 2 **(g)** 2. The answer to **(g)** must be the nearest whole number to the answer in **(f)**. Using the answer to **(g)** candidates are asked to suggest an acid of general formula H_2A, examples of which are H_2SO_4 and H_2CO_3. A mark is not given for using H_2A as an example but it may be used in an equation in **(h)(ii)**. Whichever acid is selected the equation must be correct in terms of formulae and balancing.

Throughout this question any incorrect answer may be used in subsequent parts and gain marks accordingly. For example an answer of 1 or 3 in **(g)** may gain both marks in **(h)**.

Question 9

(a) A coloured solution suggests that transition metal ions are present.

(b)(i) A green precipitate is produced which **(ii)** is insoluble in excess.

(b)(iii) A gas or ammonia is released which turns litmus blue. The ammonia mark can only be gained if a positive test for ammonia is given.

(c) Sulfate ions are confirmed by reaction with aqueous barium chloride or nitrate together with hydrochloric or nitric acid which produces a white precipitate.

(d) Chloride ions are confirmed by reaction with aqueous silver nitrate and nitric acid which produces a white precipitate.

In tests **(c)** and **(d)**, three marks are available for each correct answer. If the acid is omitted or not specified, one mark is lost in each case.

Correct formulae for the compounds making up mixture **V** are NH_4Cl and $FeSO_4$ or $(NH_4)_2SO_4$ and $FeCl_2$. Two marks are awarded for a correct combination.

Question 10

(a) The correct temperatures as read from the thermometer diagrams are 32, 55, 69, and 80. One mark is awarded if all the temperatures are correct.

(b) Candidates are asked to plot both sets of temperatures on the grid. A straight line should be drawn through the points for potassium chloride and a smooth curve through those of potassium chlorate.

Candidates are instructed to extend both lines through the y-axis at the lower ends and to extend the upper ends until they cross. Candidates who do not do as instructed lose a mark in each case.

(c) Marks are awarded in **(c), (d)** and **(e)** according to the candidate's graph.

Approximate answers are: **(c)(i)** 0.35 g, **(ii)** 2.6 g, **(d)** 75°C **(e)** 35 g/100 g of water.

(f) This question requires the candidate to analyse a point on each graph. The point 2.0 g of potassium chlorate(V) in 10.0 g of water at 40°C lies above the line on the graph, hence some undissolved solid would be seen in the solution in the boiling tube.

With reference to the potassium chloride straight line the point lies below the line, hence all the solid would dissolve and a colourless solution would be seen.

A large number of candidates gave good answers to this question showing a good understanding of the underlying theory.

(g) Candidates were asked to compare the effect of increasing the temperature on the solubility of each of the salts. The graphs show that the solubility of potassium chloride increases linearly compared to the solubility of potassium chlorate(V) which increases faster as the temperature increases.