CHEMISTRY

Paper 5070/11
Multiple Choice

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

General Comments

Candidates found the first questions of the paper more straightforward than later questions. A few questions had more candidates choosing an incorrect answer rather than the correct answer. Over all the paper was a good test of candidate ability.

Comments on Specific Questions

Question 10

Each nitrogen atom in hydrazine has a lone pair of electrons in its outer shell and two electrons in its inner shell of electrons. Thus in a hydrazine molecule there are eight electrons not involved in bonding.

Question 14

In the electrolysis of dilute sulfuric acid, oxygen and hydrogen gas, the constituents of water, are prod
The volume of water is decreasing and consequently the acid is increasing in concentration.

Question 15

Knowledge of the charge on the different metal ions was essential for obtaining the correct answer. When one mole of silver ions are discharged 108 g of silver are deposited at the cathode. At the same time 103.5g of lead, 32 g of copper and 9 g of aluminium are deposited.

Question 26

This question tested the ability to recall the order of the metals in the reactivity series. Candidates opting for alternative **D** were assuming, incorrectly, that the higher a metal is in the reactivity series the easier it is to reduce its oxide using carbon.

Question 30

The knowledge required to answer this question was not well known.

Question 31

This question was not used when awarding marks for the paper. It was considered that there is insufficient clarity over whether aquatic plants die before the decrease in dissolved oxygen, or the reverse, to allow candidates to discriminate between options **C** and **D**.

Question 34

Nylon has an amide linkage and the fat shown in the question does not have an amide linkage. This was a strong indication that **C** was the answer.

Question 36

Although ethene is unsaturated, the polymer called poly(ethene) is saturated and does not decolourise bromine water. Thus **B** was incorrect.

CHEMISTRY

Paper 5070/12
Multiple Choice

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

General Comments

Over all the paper was a good test of candidate ability. Candidates should be aware that every word in the stem of a question is important and missing the significance of just one word can lead to an incorrect response.

Comments on Specific Questions

Question 3

Answer **A** proved popular although recall of the description in the syllabus of petroleum as a mixture of hydrocarbons should have allowed candidates to discount this option.

Question 6

An entity with a simple molecular structure has covalent bonding holding its atoms together but thos may not be the same.

Question 7

Hydrogen chloride is a gas at room temperature and as a consequence its boiling point must be below 25°C making alternative **A** the correct answer.

Question 10

Some candidates had difficulty in deciding whether NH_3 or NH_4 was the formula of ammonia.

Question 21

This question tested the ability of candidates to recall the order of metals in the reactivity series. Candidates opting for alternative **D** were incorrectly assuming that the higher a metal is in the reactivity series the easier it is to reduce its oxide using carbon.

Question 22

This question was not used when awarding marks for the paper. It was considered that there is insufficient clarity over whether aquatic plants die before the decrease in dissolved oxygen, or the reverse, to allow candidates to discriminate between options **C** and **D**.

Question 31

The electrolyte used in the manufacture of aluminium is a mixture of molten aluminium oxide and cryolite not a solid mixture of aluminium oxide and cryolite.

Question 36

The key to this question was the realisation that a carboxylic acid must contain two oxygen atoms.

CHEMISTRY

Paper 5070/21
Theory

Key Messages

To be successful in calculations candidates must organise their answers in a clear and coherent way. Candidates should quote the equations used, followed by the correct substitution of data.

Answers to questions requiring longer answers need to be organised in a logical way. Bullet points may be a way to help candidates organise their answers.

General Comments

Good answers to questions used the correct chemical terms but many candidates gave imprecise and vague answers to questions that needed a longer response. Candidates did not always present their answers in a logical sequence for example in the description of reactions in the blast furnace or the preparation of zinc sulfate.

Candidates often found it difficult to construct equations involving fractions or compounds with unusual formulae.

Candidates often did not organise their answers to quantitative questions which made it difficult to award marks for errors carried forward. Candidates should be advised to show all the steps in a calculation so that Examiners can easily credit the working out.

Comments on Specific Questions

Section A

Question A1

(a) Some candidates were able to identify iron(II) chloride but common errors were iron(III) chloride and copper(II) sulfate.

(b) Many candidates recognised carbon dioxide but a common misconception was to give the other product of the decomposition namely calcium oxide.

(c) Some candidates identified nitrogen dioxide as a product formed during lightning storms but common misconceptions were sulfur dioxide or carbon monoxide.

(d) Many candidates selected calcium oxide as a basic oxide.

(e) Some candidates recognised that carbon dioxide was formed during the complete combustion of ethane. Other candidates gave carbon monoxide and some gave ethanol.

(f) Although some candidates selected silver chloride two common mistakes were silver iodide and copper(II) sulfate.

Question A2

This question was about the homologous series called the alkenes.

(a) The general formula for the alkenes was well known.

(b) Candidates were often able to describe some characteristics of homologous series. Good referred to the same functional groups or similar chemical properties. Candidates who men the gradation of physical properties of alkanes often referred to a specific physical property such boiling or melting point. A common misconception was to refer to similar physical properties rathe than a trend in the physical property.

(c) (i) The best answers referred to the use of heating or a high temperature and a catalyst. Many candidates gave the name of an incorrect catalyst for example sulfuric acid or phosphoric acid however the mark scheme allowed the award of a mark providing that the word catalyst was linked to the name of an incorrect substance. Candidates who stated a temperature often quoted a value outside that given in the mark scheme.

(ii) Candidates were often able to write the correct equation for the cracking of tetradecane however some candidates gave hexene rather than octene.

(d) Some candidates were able to give the correct mechanism as addition but polymerisation and substitution were common incorrect answers.

(e) The most common correct answers given related to the lack of electrical conductivity and the low melting point or boiling point. Less common answers referred to the lack of solubility of the compound in water.

(f) Although many candidates appreciated that ozone absorbs radiation, candidates did not always refer to ultra-violet radiation. Only the better answers then linked the presence of the ozone layer to a reduction of cataracts or skin cancer. Candidates often referred to cancer but did not specify it was skin cancer which was required by the mark scheme.

Question A3

This question was about calcium chloride.

(a) Many candidates could give the electronic configuration for calcium. Some candidates used sub-shell notation giving answers such as $1s^22s^22p^63s^23p^64s^2$. This answer was given full credit but is beyond what is expected in the syllabus.

(b)(i) The definition for isotopes was well known, however, some candidates gave imprecise answers such as elements having the same number of protons but different number of neutrons. Candidates either had to use the terms atomic number and mass number or make it clear that they were referring to atoms rather than elements.

(ii) Candidates often could complete the table and the most common misconception was in getting the number of neutrons incorrect typically giving answers such as 42 and 48.

(c) (i) Candidates often got the formula for calcium chloride incorrect, typically giving the formula of $CaCl$ rather than $CaCl_2$ and as a result could not balance the equation. The formulae for carbon dioxide and water were well known.

(ii) Candidates were more likely to get the correct electronic configuration than quote the correct charge on the calcium ion and the chloride ion. Some candidates gave the sub-shell notation as in part **(a)** and as already noted, this is beyond the scope of the syllabus. Typical misconceptions for the formulae of the ions included Ca^+, Cl_2^{2-} and Cl^{2-}.

(d) (i) Candidates often gave the correct products although some did link the products to the wrong electrodes. Some candidates did not read the question carefully and gave products that came from the electrolysis of aqueous calcium chloride.

(ii) Although many candidates appreciated that hydrogen is formed at the cathode during the electrolysis of aqueous calcium chloride other candidates gave oxygen or calcium.

(iii) Good answers referred to ions not being able to move although a common misconception was that there were no free electrons.

Question A4

This question was about gases in the atmosphere and pollution.

(a) Many candidates could recall the percentage by volume of oxygen and nitrogen in clean air, although some did not quote values within the range given in the mark scheme.

(b) Fractional distillation was well known.

(c) The most common harmful effect of nitrogen dioxide was as acid rain. Other candidates referred to ozone depletion although photochemical smog was hardly ever mentioned by candidates.

(d) Many candidates took note that the products of the reaction were water and carbon monoxide although some gave carbon dioxide or gave a hydrocarbon, carbon monoxide and water. A small proportion of the candidates wrote balanced equations but used the symbol O for oxygen and so were not awarded any marks for the equation.

(e) Candidates often appreciated that the rate of reaction would be increased although some were less precise and only referred to the rate of reaction being altered or changed. The best answers also referred to the activation energy being lowered.

(f) The very best answers gave a balanced equation as part of their answer; this was awarded both marks for the question. To be awarded both marks for the questions the candidates had to clearly describe that carbon monoxide was converted to carbon dioxide and nitrogen dioxide to nitrogen. Some candidates referred to nitrogen dioxide being reduced to nitrogen(II) oxide rather than nitrogen.

Question A5

This question was about hydrogen peroxide.

(a) Many candidates gave the correct answer of 94%. Any number of decimal places was allowed providing that the number had been correctly rounded. Candidates who could not calculate the percentage by mass often got a mark for calculating the relative formula mass of hydrogen peroxide. A significant number of candidates did not organise their answers logically.

(b) Many candidates did not include two measurements and often forgot the reference to time. A common misconception was to refer to the volume of the water rather than the volume of the gas or oxygen. A significant proportion referred to the total volume being formed and the time taken for the whole reaction rather than measuring the volume of gas formed at various times.

(c) Although a significant proportion of candidates stated that the reaction was faster many could not explain why. Candidates rarely mentioned that there would be a higher collision frequency or that the particles were more crowded.

(d) Candidates were much more likely to refer to the enzyme being denatured rather than the yeast dying, although either response was allowed.

Section B

Question B6

This question focused on the chemistry of iron and steel.

(a) The best answers included at least four word or symbol equations. Other good answers described the reactions in word form. Many answers focused on the removal of slag rather than the formation of iron. The reaction of carbon with oxygen to make carbon dioxide was well known although some candidates gave carbon monoxide as the product. Many candidates appreciated that carbon or carbon monoxide reacted with the iron ore however some candidates did not recognise that iron was the product of this reaction. A common misconception was that limestone itself removes sand, without mention of the decomposition of limestone and the reaction of silicon(IV) oxide with the calcium oxide formed.

(b) Many candidates did not make a comment about both iron and steel/the alloy. Answers given without referring to either layers or atoms sliding, and just referring to malleability.

(c) (i) Candidates were often able to calculate the amount of iron in moles as 0.0375. Candidates who rounded this answer to 0.038 were given full credit in the mark scheme. Some candidates used the atomic number rather than the relative atomic mass in the calculation.

(ii) Candidates were often able to calculate the amount in moles of hydrochloric acid as 0.005. Some candidates used the stoichiometry in the equation and the mass of iron to work out the moles of hydrochloric acid rather than the data given in the stem of the question.

(iii) Some candidates were able to be awarded a mark for error carried forward having stated a value for the moles of hydrogen. Other candidates were confused by the units for the volume and used the wrong unit, whether dm^3 or cm^3, for their answer. A significant proportion of candidates did not use the stoichiometry of the equation to link moles of hydrochloric acid with the moles of hydrogen.

Question B7

This question focused on polymerisation of chloroethene.

(a) (i) Many candidates could deduce the empirical formula as CH_2Cl. A small proportion of candidates used the atomic number rather than the relative atomic masses to calculate the mole ratio of elements. Other candidates divided through by the smallest mass rather the smallest amount in moles.

(ii) Candidates could often use the relative molecular mass to deduce the molecular formula as $C_2H_4Cl_2$ providing they had the correct empirical formula from part **(a)**.

(b) Some candidates could draw a section of the polymer, the best answers included both the 'free' end bonds, brackets and the 'n'. A common misconception was to include the double bond within the structure or not to include the 'free' end bonds.

(c) Candidates often only made one comment either about addition polymers or about condensation polymers rather than a comment about each one. The most common answer was that water was formed when condensation polymers are formed but not when addition polymers are formed.

(d) (i) Many candidates found this equation very demanding and either could not balance the equation or included incorrect formulae.

(ii) This equation was more straightforward. The most common mistake was touse the incorrect formula for copper(II) chloride, using $CuCl$ rather than $CuCl_2$.

(iii) Many candidates could refer to at least one correct physical property but often included a chemical property rather than a physical property as their second answer.

Question B8

This question focused on zinc sulfide and zinc sulfate.

(a) Candidates often gave one difference between a mixture and a compound but rarely gave two differences. Answers often lacked precision, for example stating that a compound needs energy without stating whether this referred to making or separating the compound. The most likely correct answers referred to being able to easily separate a mixture but not a compound, and the idea that a compound has a fixed proportion of zinc and sulfur but a mixture does not.

(b) Candidates were often able to complete the energy profile diagram by putting the products lower than the reactants, however, they often could not correctly label the enthalpy change. A common misconception was to label the products with the incorrect formula when the mark scheme allowed the use of just the word product. In terms of the enthalpy change most candidates gave double headed arrows rather than showing the correct downward direction. Other candidates labelled the enthalpy change as the activation energy and some drew a line from the *x*-axis.

(c) Many candidates could deduce the empirical formula as ZnS although some just gav... of zinc and sulfide ions shown in the diagram.

(d) Many candidates referred to partial ionisation or dissociation in their answers. A co... misconception was to refer to a low concentration of hydrogen ions without mentio... dissociation. Some candidates confused "dissolve" with "dissociate".

(e) (i) Although some candidates could write the ionic equation many included the sulfate ion in their equation.

(ii) Candidates found this question very demanding. Candidates rarely mentioned the use of excess zinc and were more likely to mention the filtering stage. The crystallising stage was not well known and often candidates did not clearly describe the partial evaporation of water to get a saturated solution. A common misconception was to evaporate the solution to dryness.

Question B9

This question focused on ethanoic acid, esters and neutralisation.

(a) Candidates could often write the formula for sodium ethanoate although some included an equation without labelling which formula was the salt. Some candidates included the charges on the ions which was awarded the mark for the question.

(b) Candidates often included the ethanoate ion in the equation and did not recognise the equation as that of the neutralisation of an acid with an alkali.

(c) (i) Although many candidates described the correct shift in the position of equilibrium only a very small number of candidates could give an adequate reason.

(ii) Although many candidates described the correct shift in the position of equilibrium only a very small number of candidates could give an adequate reason. Some candidates referred to an exothermic reaction but did not specify that it was the backward reaction.

(d) Many candidates could deduce the correct molecular formula.

(e) Many candidates recognised the importance of the hydroxide ion but a common misconception was to include both the Na^+ and the OH^- without specifying which ion was associated with the properties of an alkali.

(f) (i) Many candidates could use the data to get the amount in moles of hydrochloric acid as 0.0025.

(ii) Many candidates could use the data to get the amount in moles of the metal hydroxide as 0.00125.

(iii) Most candidates did not appreciate the significance of the answers to parts **(i)** and **(ii)** and as a result gave the formula as **M**OH and wrote the equation for this type of metal hydroxide.

(g) Many candidates recalled that calcium hydroxide was used to reduce the acidity of soil. Common incorrect answers included sodium hydroxide, magnesium hydroxide and zinc hydroxide.

CHEMISTRY

Paper 5070/22
Theory

Key Messages

- Basic knowledge of simple inorganic chemistry was good. More practice is required in writing and balancing unfamiliar equations, including ionic equations, and in deducing the formulae of compounds from the charges on their ions.
- Ideas about structure and bonding especially the difference between molecules and giant structures and the relationship between structure and properties would benefit from more revision.
- Many candidates would benefit from more practice at answering extended type questions involving industrial processes with the accuracy required.
- A greater understanding of scientific terms is required when writing about environmental aspects of chemistry including the carbon cycle and greenhouse gases.
- Some candidates require more practice at reading all parts of a question carefully so that they do not miss essential information.
- Calculations, especially in ***Section B***, were done well by many candidates. Others need to take care with the layout of their answers.
- Many candidates need more practice at answering questions about practical aspects of chemistry, for example, salt preparation.

General comments

Many candidates tackled this paper well, attempted most parts of each question in ***section A*** and gained good marks in this section. More practice is required in setting out answers to questions involving a free response (extended prose) e.g. **A3(e)**, **B6(a)** and **B8(b)(ii)**. In all questions, candidates are encouraged to write as precisely and scientifically as possible in order to give sufficiently specific answers (e.g. in **Question 2(a)** where many candidates did not link the density to the <u>increase</u> in the number of carbon atoms); to avoid contradicting themselves (as often found in question **Question B8(b)(ii)**); and to avoid writing too vaguely or non-scientifically. The last was especially apparent in questions on environmental chemistry e.g. **A4(a)** and **(b)**, where answers were either not specific enough or confused different environmental processes e.g. destruction of ozone layer, acid rain, global warming.

Candidates' knowledge of structure and properties in terms of atoms, ions and electrons was fairly good. Many could write the electronic structure of silicon(IV) chloride. An area which would benefit from further study is structure and bonding. Many candidates could not distinguish between giant structures and simple molecules (**Question A3(e)**) and often used the term "molecule" without consideration of its meaning. The physical properties of molecular substances were not well known (**Question A3(d)(i)**).

Aspects of inorganic chemistry were fairly well answered, especially in **Question 1**. The writing of balanced equations was not always successful, a major obstacle for some candidates being to work out the formulae of simple species such as magnesium chloride, sodium carbonate and ammonium sulfate.

Many candidates performed fairly well on the main question about organic chemistry (**Question A2**). Others need more practice in deducing the names and structures of esters.

Candidates often performed well in questions involving calculations. A minority showed appropriate working and clear indications about what each number referred to. Most did not make it clear where their figures came from or put figures into standard equations incorrectly. In order to gain appropriate marks, candidates should make it clear why they are performing certain steps.

Practical aspects of chemistry e.g. **B9(e)** (preparation of calcium chloride crystals) posed challenges for many candidates.

Comments on specific questions

Section A

Question A1

This was the best answered question on the paper with candidates showing good knowledge of inorganic chemistry. Candidates could improve their performance by ensuring they have read each question part carefully.

(a) This was the least well answered part of this question. The most common incorrect answer was hydrogen, indicating that the candidates either did not read the word “anode” or thought that the hydrogen ion is negatively charged.

(b) Many candidates correctly chose nickel as the catalyst in the manufacture of margarine. The commonest incorrect answer was vanadium.

(c) Some candidates appeared to miss the word “solid” and suggested oxygen rather than sulfur.

(d) Nearly all candidates realised that potassium is higher than sodium in the reactivity series.

(e) Many candidates identified silver as being in Period 5 of the Periodic Table. The most common wrong answer was to suggest nitrogen, mistaking groups for periods.

(f) Many candidates identified zinc correctly. The commonest incorrect answer was to suggest vanadium, which being a transition element has a coloured oxide. Candidates should note that the Examiners will not expect them to know whether specific transition metal oxides are acidic, basic or amphoteric unless information is given.

Question A2

Many candidates scored well in this question. Parts **(a)(ii)** and **(b)(i)** were particularly well done. Questions involving writing and naming organic structures were less well done. More practice is needed in the area of writing and naming organic structures.

(a) (i) A significant proportion of the candidates gained the mark for describing the trend of density with the variation in the number of carbon atoms. The commonest errors were: to write that density increased without mentioning that this was related to the increase in the number of carbon atoms; to relate density to boiling point rather than number of carbon atoms.

(ii) Nearly all candidates were able to name ethanoic acid when given its formula.

(iii) A minority of the candidates gave the correct structure of propanoic acid. A large number omitted the O-H bond. Other incorrect answers were: to write the formula of butanoic acid; to make errors in the structure of the carboxylic acid group, with aldehydes or double bonds to hydrogen being often seen.

(b) (i) Many candidates deduced the formula of pentanoic acid correctly. The most common error was to write the molecular formula for butanoic acid.

(ii) A majority of the candidates gave values within the range allowed (180-195^{o}C). Many were close to this range and very few gave values which bore no relation to the trend.

(c) (i) Many candidates realised that an acid reacts with a metal to form hydrogen. The commonest error was to suggest carbon dioxide, possibly through focussing on the COO part of the carboxylic acid group rather than considering the acidic nature of the compound.

(ii) A minority of the candidates gave the correct formula of sodium butanoate. Common errors included: too many hydrogen atoms or too few hydrogen atoms; only one oxygen atom; thinking that sodium has two charges, thus giving formulae such as $(C_3H_7COO)_2Na$. The last may arise from similar questions in past papers where the formula of the calcium or magnesium salt was requested. A significant number of candidates did not respond to this question.

(d) (i) Most candidates realised that a catalyst increases reaction rate. Fewer scored th lowering activation energy. Many wrote only that a catalyst is not used up in the reaction.

(ii) A majority of the candidates were able to give a correct use for an ester.

(iii) Very few candidates named propyl methanoate correctly. Common wrong answers included: methyl propanoate; butanol (through ignoring the CO group); butyl compounds.

Question A3

Some candidates gave good, detailed answers to many parts of this question. Many candidates gave good answers to parts **(a)** and **(b)** about atomic structure. More practice is needed at questions involving structure and bonding and how these relate to physical properties (parts **(d)(i)** and **(e)**).

(a) Most candidates gave the correct electronic configuration for a silicon atom. The commonest error was to suggest 2,8,8,8,2. The most likely cause is that the candidates referred to the 28 nucleons in part **(b)** of the question instead of using the Periodic Table.

(b) Nearly all the candidates were able to deduce the correct number of subatomic particles in the two isotopes of silicon. Some candidates considered electrons as if they were neutrons or calculated the number of neutrons incorrectly.

(c) Many candidates constructed the correct equation. Common wrong equations included the terms $4Cl$, Si_2, Si_4 and $4SiCl$.

(d) (i) Many candidates wrote about chemical rather than physical properties. Others thought that silicon(IV) chloride would either be ionic or that the silicon is a metal despite the hint in the stem of the question that silicon(IV) chloride is a simple molecular compound. The most frequently seen wrong answers were: electrical conductor; high melting and boiling point. A significant number mentioned solubility despite the instructions in the stem of the question.

(ii) Many candidates drew a correct structure for silicon(IV) chloride though some did not draw the non-bonding electrons. Others drew an incorrect number of electrons around the chlorine atoms, often missing a non-bonding pair on one or more of these atoms.

(e) Most candidates scored the mark for the idea of strong bonding but few gained the mark for implying a giant covalent structure. Many candidates disadvantaged themselves by writing about molecular structure, van der Waals forces, or intermolecular bonding. A few thought that the structure was ionic.

Question A4

Few candidates scored well on this question. The environmental chemistry in parts **(a)** and **(b)** was not well known (carbon cycle and greenhouse gases).

(a) (i) Many candidates missed a mark by not specifying the combustion of specific carbon compounds. Similarly, the non-specific reference to decomposition without qualification did not gain candidates a mark. Smoke from vehicles and reference to factories unqualified were often seen as answers which were too vague to award credit. The most common correct answer was “respiration” although some suggested “breathing” which was not permitted.

(ii) A majority of the candidates gave the correct response “photosynthesis”. A common error was to suggest “respiration”. Many candidates gave this despite giving it as an answer in part **(i)**.

(b) (i) Hardly any candidates realised that greenhouse gases absorb infrared radiation. Those having the correct idea that greenhouse gases absorb thermal energy sometimes went on to suggest that they trap heat from the sun, thus forfeiting the mark. A significant number of candidates took the term literally and wrote about gases in greenhouses and their effect on plants. Others referred to ultraviolet radiation or sunlight rather than infrared radiation reflected from the Earth.

(ii) Candidates often struggled to name another greenhouse gas. Common errors we[illegible]t carbon monoxide and sulfur dioxide. Few gave suitable sources of the correct greenh[illegible] The best answers were seen when methane had been chosen. Those who put ozone [illegible] generally get the second mark because they wrote about ozone depletion.

(c) (i) Many candidates were able to describe the meaning of the term "weak acid" though many referred to low concentration of hydrogen ions rather than degree of dissociation. Candidates should bear in mind that a strong acid at very low dilution will have a low concentration of hydrogen ions. Some candidates wrote "dissolves" instead of "dissociates".

(ii) A significant number of candidates omitted this question. Many candidates who suggested using universal indicator did not gain the second mark because they did not make a clear statement about comparing the colour with a chart. Other errors included the use of litmus or other single indicators; using a pH meter (despite the instruction in the stem of the question).

(d) A minority of the candidates were able to balance the equation for the decomposition of sodium hydrogencarbonate. The most common mistake was to write the formula of sodium carbonate as $NaCO_3$.

Question A5

Many candidates scored over half marks for this question. The calculation in part **(c)** was well done by many candidates though others did not respond.

(a) Many candidates were able to write a balanced equation for the reaction of magnesium with hydrochloric acid. Common mistakes were to write the formula of magnesium chloride as $MgCl$ or to missing the balance of the hydrochloric acid.

(b) (i) Candidates were often able to score one mark of the two available. The most common mistakes were: missing the units on the axes; labelling the vertical axes as rate, time or mass.

(ii) Few candidates scored both marks and many did not score. Common errors were to give a line steeper than the original, to finish the line at a lower level, or to not label the two lines A and B.

(c) This question was generally well answered. Most of those who did not score both marks obtained a mark though error carried forward or correct molar mass of magnesium carbide. Those who did not score generally had made no attempt to answer the question.

Section B

Question B6

Few candidates scored highly on this question. The answers to part **(a)** indicated that many candidates need more practice at answering free response questions with the accuracy required.

(a) Very few candidates scored all four marks on this question. Most scored the marks for the equation at the cathode or for mentioning carbon electrodes. The main errors made were: the presence of OH^- ions in the equation for the reaction at the anode; electrons on the wrong side of the equation (for both the anode and cathode reaction); incorrect balancing; $3Al$ or Al_3 on the right hand side cathode equation (when just one Al on the left); suggesting that bauxite is the electrolyte rather than aluminium oxide; suggesting that cryolite lowers the melting point of (pure) aluminium oxide rather than lowering the melting point of the electrolyte mixture; putting the anode and cathode reactions the wrong way round.

(b) (i) Many candidates wrote that aluminium is "light" rather than using the correct scientific term, "low density". Properties such as "malleable" and "ductile" were often seen. Although such properties are useful in forming an aircraft fuselage, the overriding property is the low density.

(ii) Many candidates missed the "electrical" which was required by the mark scheme. Properties such as "ductile" and "strong" were often seen. Although such properties are useful in forming electrical cables, the overriding property is the electrical conductivity.

(c) (i) This question was better answered than similar questions in previous years. Neve candidates gained both marks. Most candidates referred to the oxide layer but many c the second mark because they just referred to "preventing the aluminium from reacting" in referring to the properties of the oxide layer. Some answered by referring, incorrectly, relative reactivities of the two metals.

(ii) Many candidates correctly identified a suitable type of reaction. Others erroneously suggested "reduction" or "exothermic".

(iii) Many candidates wrote the correct formula for aluminium sulfate. Common mistakes included $AlSO_4^-$ and $Al(SO_4)_2$.

Question B7

This was the best answered of the part **B** questions. The calculation in part **(d)** was generally well done. More practice is needed in deducing the structure of a monomer from a given polymer (part **(c)(ii)**).

(a) A significant proportion of the candidates understood the meaning of the terms "unsaturated" and "hydrocarbon" though a number of candidates omitted the important word "only" when defining a hydrocarbon. Others disadvantaged themselves by suggesting that hydrocarbons are elements.

(b) (i) Many candidates scored a mark for the conditions needed for cracking. Others suggested numerical values of temperatures which were too high or low instead of simply giving "high temperature". Many chose the wrong catalyst but were allowed the mark because they understood that a catalyst is used.

(ii) A large proportion of the candidates were able to balance the equation for cracking. Some candidates wrote the formula of a product containing an odd number of hydrogen atoms. Others did not gain the mark because they wrote the formula for ethane rather than ethene.

(c) (i) A good number of candidates knew a suitable use of poly(ethene). "Plastic bags" was the correct response which was most often seen. Many answers such as plastics, clothes and containers were not sufficiently specific to gain a mark.

(ii) A minority of the candidates were able to deduce the correct structure of the monomer. Many candidates either drew a single repeat unit or drew the monomer without the double bond. Others drew side chains other than C_2H_5 or drew two C_2H_5 groups in the monomer. A considerable number omitted this question.

(d) Many candidates scored all three marks in the calculation. Of the others, most scored only one mark, for a calculation of 5% yield somewhere other than in the final stage of the calculation (often as 0.02 from 0.4 x 5/100). Others completed the rest of the calculation correctly but forgot that the yield was only 5%. Candidates would benefit by laying their work out in a logical order.

Question B8

This question was not answered well, apart from the calculation in part **(b)(i)** which was reasonably well done by many candidates.

(a) Many candidates gave a full explanation of the term dynamic equilibrium. The commonest error was to suggest that the amounts of reactants and products are the same at equilibrium.

(b) (i) Many candidates scored both marks. Common errors were: to multiply 0.94 by 128 without any further working; to use the molar gas volume; to use 127 as the molar mass of hydrogen iodide; to use the concentration of hydrogen in the calculation rather than the concentration of hydrogen iodide.

(ii) Few candidates scored both marks. Common errors included: not mentioning temperatures; making contradictory statements e.g. both reactants and products increasing with increasing temperature. Candidates would have benefitted from writing better organised answers and selecting the relevant information from their knowledge of equilibrium. Very few mentioned that the reaction was endothermic.

(c) Many candidates drew the diagram for an exothermic reaction but often obtained th[...] forward mark for an upward-pointing arrow. A considerable number of candidates dr[...] headed arrows for the enthalpy change thus losing the mark. A small number of ca[...] contradicted themselves by suggesting that hydrogen iodide was a product.

(d) A minority of the candidates knew the test for iodide ions. Most of these also got the mark for the observations. A significant proportion did not know the test at all and left the answer lines blank. Common errors in choice of reagent included litmus, sodium hydroxide and hydrochloric acid.

Question B9

As with other questions, candidates proved better at calculations than at questions involving extended writing.

(a) Many candidates gave answers which were too vague to be awarded credit, for example, a non-specific statement of adding minerals. The best answers referred to increased growth or increased yield. Some candidates confused fertilisers with other compounds and made reference to action as insecticides or neutralisation of acidic soil.

(b) Few candidates wrote a correctly balanced equation as many were not able to write a correct formula for ammonium sulfate.

(c) (i) A majority of the candidates recognised that the OH^- ion is responsible for alkalinity. Others suggested calcium ions and a few candidates did not put the negative charge on the OH and so forfeited the mark.

(ii) Of the candidates who realised that ammonia was formed, the majority also suggested the idea that ammonia is a gas or escapes readily from the soil. Others thought that nitrogen gas is formed or that nitrogen or other incorrect substances dissolve in the soil.

(d) Many candidates were able to score the mark for recognising the 2:1 ratio of hydrochloric acid: calcium hydroxide though some reversed the ratio. As with the other calculation questions in this paper, many candidates did not lay out their calculation in a logical manner. A considerable number of candidates used an alternative method involving substitution in a single equation. Whilst this method is acceptable, it leads to a greater possibility of making errors. Candidates using this method more often put the numbers in the wrong places, especially the 2:1 mole ratio.

(e) Few candidates scored full credit. Candidates were most likely to get the mark for heating to crystallisation point. Common errors included: heating to get the crystals or heating to dryness; mentioning filtration in the incorrect context; going straight from crystals to drying them without removing the crystals by filtration or crystal picking; not mentioning what the crystals are dried with.

CHEMISTRY

Paper 5070/31
Practical Test

Key messages

In calculations, candidates should be encouraged to follow all instructions given in order to prevent the unnecessary loss of marks.

In qualitative tests, candidates should be encouraged to record observations accurately, using suitable terminology and making use of the Qualitative Analysis Notes.

General comments

Overall, candidates performed well and were prepared for the test. In **Question 1** many demonstrated capable practical skills in carrying out the titration and recorded and processed the data appropriately. While the results of the qualitative tests were generally well described, there is still scope to secure more marks in this section simply by making closer reference to the Qualitative Analysis Notes. Supervisors are thanked for providing the required experimental data to enable assessment of their candidates' work.

Comments on specific questions

Question 1

(a) Candidates obtained full marks for their titration results by recording initial and final burette readings to 1 or 2 d.p., obtaining at least two titres within 0.2 cm^3 of the Supervisor's value and then correctly averaging two or more ticked results that did not differ by more than 0.2 cm^3.

While there were a considerable number who scored full or nearly full marks, there were some whose titres were considerably different from the Supervisor's value. Nevertheless, most of the candidates obtained and selected concordant titres, which they correctly averaged. Once again there were a number of candidates who performed unnecessary extra titrations – producing four other titres, after achieving concordance with the first two – and leaving themselves less time to complete other parts of the paper.

In the calculations that followed, most candidates persisted in attempting all the parts and as a result secured numerous marks in what was a challenging part of **Question 1**.

(b) Many recognised the need to multiply 0.2 by the average titre and divide by a 1000 but some used the volume of **P** instead of **Q** and others forgot the 1000.

(c) The major cause of loss of marks for those who had been successful in **(b)** was using 0.2 instead of 0.02 as the concentration of sodium carbonate. This then led to a problem in **(e)** when the amount of acid used in reaction with the carbonate exceeded the amount of acid present in the average titre of **Q**.

(d) Providing the answer from **(c)**, regardless of whether it was right or wrong, was doubled, the mark was awarded.

(e) It was clear that a number of candidates did not take the instruction from the question to use the answers from **(b)** and **(d)**. Some of those that did then added the moles together and others, because of an earlier error, felt forced into an incorrect subtraction. Any attempt to subtract the answer in **(d)** from that for **(b)** was credited.

(f) As with **(b)** many successfully multiplied the answer from **(e)** by 1000 and divided by [the mass of] **P** despite any previous problems in **(c)** – **(e)**.

Question 2

All the points noted in the mark scheme were awarded in the assessment of the examination scripts. While marks were frequently lost for incomplete, rather than incorrect, answers, there were also examples of poor use of terminology. It is important that instructions are carefully followed, especially those regarding the testing and naming of gases and that terms such as "precipitate" and "solution" are used precisely. Teachers should continue to encourage candidates to make full use of the Qualitative Analysis Notes supplied on the last page of the exam paper. These notes are a model for the successful recording of observations.

Test 1 Most candidates correctly reported that a white precipitate was produced in **(a)** and remained when acid was added. It was rare to find incorrect descriptions such as solution turns white or white solution.

Test 2 The gas in both Tests 2 and 3 was colourless and odourless so the evidence for its presence was the bubbling/fizzing/effervescence in the liquid. The gas in Test 2 pops with a lighted splint and is hydrogen. Recording that the gas pops or is tested with a splint (lighted or not) is not sufficient to score a mark for the correct test. After correctly recording the test, some candidates did not name the gas. A few noted the disappearance of the metal but generally they did not report the bubbling or identify the gas

Test 3 As with Test 2, it was not uncommon to find incomplete answers such as "bubbles of carbon dioxide" or "gas produced which turns limewater milky" each of which score only one mark, when the full description and identification would score three marks. Few candidates noted the observation of the solid carbonate disappearing in the acid.

Test 4 Although this was very similar to Test 1, not as many candidates scored both marks. There were some reports of the solution turning yellow or green, and some believed the precipitate dissolved in acid.

Test 5 The filtrate from the reaction in **(a)** contains iodine as a result of the oxidation of iodide ions by the manganese(IV) oxide. A mark was scored for correctly describing the colour of the filtrate. Once starch is added to the filtrate, the liquid turns blue-black. Purple-blue or purple-black is not an acceptable description.

Test 6 Candidates generally obtained the majority of marks in this test. In **(a)** on adding the aqueous copper(II) ions, the liquid turns brown/yellow and a solid is formed. The addition of sulfite converts iodine back to iodide, resulting in the discharge of the colour and a white solid, copper(I) iodide, remaining in the test-tube. The observation white ppt provided the final two marks. Not noting the presence of the solid in either **(a)** or **(b)** was the usual reason for not obtaining full marks.

Test 7 There was a wide variation in the marks scored in this test. A few candidates mixed the reactants thoroughly in **(a)** and recorded a black solid in a brown or yellow solution, scoring two marks. Mostly one mark was earned by reporting the liquid turns brown with or without recording a precipitate.

In **(b)** once enough alkali is added the solid disappears and a yellow, almost colourless, solution is formed. While it was clear that some did not add sufficient alkali to their product from **(a)**, there were others who did not mix the solutions sufficiently.

The addition of the acid **R** returns the mixture to its original state in **(a)** by reversing the disproportionation.

Conclusions

Out of the three marks available in the conclusions, candidates were most successful in scoring the one for identifying the anion in **R** as sulfate, and least successful in identifying the cation as hydrogen, suggesting instead aluminium, zinc, ammonium or iron. The correct formula for sodium iodide was usually given whenever a candidate recognised that iodine was present in **S**.

CHEMISTRY

Paper 5070/32
Practical Test

Key messages

In calculations, candidates should be encouraged to follow all instructions given in order to prevent the unnecessary loss of marks.

In qualitative tests, candidates should be encouraged to record observations accurately, using suitable terminology and making use of the Qualitative Analysis Notes.

General comments

The performance overall showed an improvement and there were relatively few who were unable to attempt all the questions. The titration part of **Question 1** was carried out successfully by most candidates. While the calculations produced a wide spread of marks, candidates generally worked at all the parts and demonstrated a grasp of the chemical principles involved. The recording of observations in the qualitative tests showed improvement but many candidates have the potential to score better if they can be clear and consistent in how they report what occurs. Supervisors are thanked for ensuring the success of the Practical Test by providing the required experimental data to enable assessment of their candidates' work.

Comments on specific questions

Question 1

(a) Candidates obtained full marks for their results by recording initial and final burette readings to 1 or 2 d.p., obtaining at least two titres within 0.2 cm^3 of the Supervisor's value and then correctly averaging two or more ticked results that did not differ by more than 0.2 cm^3.

There were many candidates who scored highly here, and there were few examples of unnecessary errors such as ticking less than two titration results or averaging all the titres rather than just the ticked ones.

It was encouraging to find most candidates sought to complete all the calculations and as a result they generally gained reward for their efforts in what was a challenging part of **Question 1**. Further advantage can be obtained by following the specific advice provided in each question e.g. in **(d)**, **(e)** and **(f)** 'Using your answer to….' There were a number of candidates who capably met all the demands and successfully completed all of **(b)**-**(f)**.

(b) Many recognised the need to multiply 0.1 by the average volume of **Q** and divide by a 1000 but some used the volume of **P** instead of **Q** and others omitted the 1000.

(c) Mistakes made in **(b)** were generally repeated here. In addition, there were some who used 0.2 instead of 0.02 as the concentration of sodium carbonate and this led to a problem in **(e)**, when the amount of acid used in reaction with the carbonate exceeded the amount of acid present in the average titre of **Q**.

(d) If the answer given was the same as that in **(c)**, the mark was awarded. There were numerous candidates who did not use their answer to **(c)** as instructed and used other data.

(e) Once again there were candidates who did not follow the instruction to use the answers from **(b)** and **(d)**. Any attempt to subtract the answer to **(d)** from that for **(b)** was credited.

(f) This was the most difficult calculation of the five. Those who took the advice and us[...] from **(e)** usually multiplied it by 1000/25 but many forgot to double the amount of s[...] despite the equation for the reaction being provided.

Question 2

All the points noted in the mark scheme were awarded in the assessment of the examination scripts. While most candidates followed the test instructions, those who scored highly consistently provided complete and precise observations. Teachers should continue to encourage candidates to make full use of the qualitative analysis notes supplied on the final page of the exam paper. The methods of description are ideal for securing the marks available for observations.

R was dilute hydrochloric acid. **S** was sodium sulfite.

Test 1 Virtually all the candidates correctly recorded a white precipitate on addition of aqueous silver nitrate.

Test 2 Most indicated that the precipitate remained when the acid was added.

Test 3 The disappearance of the precipitate in ammonia was not so frequently reported but when it was, the final solution was generally noted to be colourless. Answers which are contradictory e.g. ‘the precipitate dissolves to form a white solution’ or vague e.g. ‘precipitate turns colourless’, ‘solution turns colourless’ do not receive credit.

Test 4 While there were plenty of candidates who scored highly in each of **Tests 4** and **5**, marks were needlessly lost by others. The gas in both tests was colourless and odourless so bubbling/fizzing/effervescence was the evidence for its presence. In **Test 4** the gas turned limewater milky and was therefore carbon dioxide. Both the test with its result and the name of the gas are needed to score two marks.

There was little comment about the solid carbonate disappearing in the acid.

Test 5 As with **Test 4**, incomplete answers were found e.g. ‘bubbles of hydrogen’ or ‘gas produced which burns with a pop’. In addition the test for hydrogen must be made with a lighted splint, a glowing one will not ignite the gas.

A few noted the disappearance of the metal in the acid.

Test 6 It was rare to find an incorrect answer and most candidates stated the solution turned colourless.

Test 8 The solution made in **Test 7** produced a white precipitate in **(a)** which then disappeared in **(b)**, with the addition of dilute hydrochloric acid, to form a colourless solution. Virtually all noted the precipitate being formed and many its dissolving in **R**, though not all of these described the final liquid as colourless.

Test 9 Although candidates generally reported a white precipitate was formed in **(a)**, fewer noted the solid dissolved in excess of the solution of **S**. On warming the colourless solution from **(b)**, a solid was formed in **(c)** which is not white.

Test 10 When sodium sulfite is dissolved in aqueous iron(III) chloride, the solution turns red and after acidification and warming, the iron(III) ions are reduced to iron(II). There were plenty of candidates who recorded an acceptable colour in **(a)** but some of these reported a red or brown precipitate presumably confused by some undissolved **S**. Warming in most cases caused the colour to turn yellow and those who added sufficient aqueous sodium hydroxide, saw a green (or black) solid which remained in excess alkali. The mark for the insolubility of the precipitate in excess was seldom awarded.

Conclusions

Out of the three marks available in the conclusions, candidates were most successful in scoring the one for identifying the anion in **R** as chloride, and least successful in identifying the cation as hydrogen, suggesting instead aluminium, calcium or zinc. **S** was rightly more often classified as a reducing agent than an oxidising agent.

CHEMISTRY

Paper 5070/41
Alternative to Practical

Key Messages

When candidates are asked to draw a curve or straight line through a set of points, the curve/line should be extended, where appropriate, to pass through zero. It should be noted that this is only required when the curve/line, on extension, would naturally pass through zero.

In answering calculations candidates should always show all of their working, particularly where the number of marks allocated to that part is greater than zero.

In calculations based on titrations answers should be given to three significant figures except when the third figure is zero.

Candidates should be encouraged to take more care in the spelling of chemicals, apparatus and techniques to avoid ambiguity.

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, but candidates should be encouraged to show all their working. When the number of marks allocated to a calculation is greater than one, it is an indication of its difficulty and in such cases one or more of the marks will be for the working. If no working is shown and the answer is incorrect all the allocated marks for that calculation are lost.

Many candidates continue to confuse the test for hydrogen with that of oxygen. Answers such as 'relights a glowing splint with a pop' and 'burns with a pop' are often seen and are not acceptable.

Comments on specific questions

Question 1

(a) The items of apparatus were well known.

(b) (i) Most candidates correctly calculated the number of moles of hydrogen.

(ii) The equation shows that one mole of magnesium produces one mole of hydrogen and the mass of magnesium is found by multiplying the number of moles by 24. Errors in **(i)** may be carried forward such that credit may be given here even if the answer to **(i)** is incorrect.

(c) Some candidates confused the test for hydrogen, using a lighted splint, with that for oxyg[en where a] glowing splint is used.

(d) Some candidates lost the marks by answering in terms of the rate of reaction rather than the ti[me] taken as is specified in the question.

Question 2

(a) The electrolysis of copper(II) sulfate using graphite electrodes was well known and candidates were able to explain the colour change of the solution. Some lost the mark for the equation by omitting the negative charge on the electron. The electrolysis with copper electrodes was not well understood. It was insufficient to state that there was no colour change because copper ions remained in the solution.

(b) Most candidates correctly identified the gases evolved in the electrolysis of dilute sulfuric acid but the other experiments were less well known. Some candidates lost marks by giving ions as the products.

Question 3

This question was well answered. The masses of the elements are converted to moles by dividing by the relative atomic masses and the simplest ratio is then found.

Question 4

Most candidates correctly interpreted the chromatogram.

Question 5

Isomers have the same molecular formula but different structures. **A** and **C** both have molecular formula C_5H_{10}

Question 6

An alcohol reacts with a carboxylic acid in the presence of sulfuric acid to produce an ester.

Question 7

A more reactive metal will displace a less reactive metal. Magnesium and iron are both more reactive than copper.

Question 8

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 or, take the mean of titres two and three irrespective of errors in the burette readings, when it may be more appropriate to use other titres such as one and three.

In the calculations errors are carried forward so that candidates are given credit for correct chemistry even if an error has been made in an earlier part. The value of **x** in **(i)** must be given to the nearest whole number.

Question 9

(a) Many candidates correctly identified the gas and the limewater test was well known, but only a minority could write a balanced equation for the reaction between hydrogen ions and carbonate ions producing carbon dioxide and water.

(b) A colourless solution suggests the absence of transition metal *ions* in the solution. Candidates who stated that **K** is not a transition metal lost the mark.

(c)-(e) The reactions were well known. In **(d)** it was insufficient to state that there was no reaction.

Question 10

(a) The observations when zinc reacts with copper(II) sulfate were well known. Gas evolved … an acceptable observation.

(b) Most candidates scored full marks for correctly plotting the points and drawing the extended straight line as required by the question.

(c) The first mark was given for the candidate reading their own graph correctly and the second for correctly calculating the temperature rise from this. The calculation of the number of moles of copper(II) sulfate was generally correct.

(d) Most candidates correctly used their answers from previous parts to calculate the heat produced.

CHEMISTRY

Paper 5070/42
Alternative to Practical

Key Messages

When candidates are asked to draw a curve or straight line through a set of points, the curve/line should be extended, where appropriate, to pass through zero. It should be noted that this is only required when the curve/line, on extension, would naturally pass through zero.

In answering calculations candidates should always show all of their working, particularly where the number of marks allocated to that part is greater than zero.

In calculations based on titrations answers should be given to three significant figures except when the third figure is zero.

Candidates should be encouraged to take more care in the spelling of chemicals, apparatus and techniques to avoid ambiguity.

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, but candidates should be encouraged to show all their working. When the number of marks allocated to a calculation is greater than one, it is an indication of its difficulty and in such cases one or more of the marks will be for the working. If no working is shown and the answer is incorrect all the allocated marks for that calculation are lost.

It is important that care is taken in writing key words, numbers and formulae. For example in writing the formula for ethanoic acid it is sometimes difficult to differentiate between CH_3COOH and CH_5COOH and in nitric acid between HNO_3 and HNO_5.

Many candidates continue to confuse the test for hydrogen with that of oxygen. Answers such as 'relights a glowing splint with a pop' and 'burns with a pop' are often seen and are not acceptable.

Comments on specific questions

Question 1

(a) Candidates are asked to read two thermometer diagrams and insert the temperatures in the table. Care should be taken in ensuring that each temperature is placed in the correct place in the table.

If one or both of the readings is incorrect the first mark is lost but a correct subtrac... second mark.

(b) The temperature change indicates an exothermic reaction which is then used to comple... energy profile diagram for sodium hydroxide dissolving in water. In doing so candidates must dr... a horizontal straight line below the reactants line and then a vertical line to indicate the enthalpy change, ΔH.

Various products were suggested but few were able to produce the correct answer of an aqueous solution of sodium hydroxide. Although there was no penalty for no arrow on the vertical line, candidates should be aware that the arrow, in this case, should point downwards.

Many candidates confused the enthalpy change with the activation energy.

In cases where the products line is drawn above the reactants line a mark is lost but a correct indication of ΔH can score consequentially.

(c) The remaining parts of the question were generally answered well.

Question 2

(a) Both the name and formula of the acid are required to gain the mark.

(b) There are three essential stages in this preparation:

The aqueous solution must be heated;

Heating must continue until a saturated solution is formed (not to dryness);

The crystals must be removed by filtration, washed with distilled water and dried.

Washing the crystals was frequently omitted and candidates should realise that, to obtain full marks, it is necessary to an indicate when the heating should stop.

(c) To calculate the mass of nitrogen in 1000 g of ammonium nitrate candidates must initially calculate both the molar mass of ammonium nitrate (80) and the mass of nitrogen (28) in one mole.

An error in either or both of these produces an incorrect answer and loses one or both marks.

Any incorrect answer may be carried forward to part **(ii)** and, if used correctly, may gain the mark.

(d) Many good answers were offered but several candidates had difficulty with the formula for ammonium phosphate.

(e) The formula for the ammonium ion is NH_4^+ although NH_4^- was often seen.

The test for the ammonium ion was generally correct but the need to heat the test solution containing sodium hydroxide was often omitted.

Question 3

Distillation, **(b)**, is the only method that will produce a sample of pure water.

Question 4

A pipette, **(d)**, is necessary for the required accuracy of measurement.

Question 5

The correct answer is **(a)**, the rate of decomposition of hydrogen peroxide increases, since a catalyst increases the rate of a reaction but does not affect the yield.

Question 6

The correct answer is **(b)**, C_3H_6, as 0.2 mol bromine is used, giving a molar mass for the alkene of 42.

Question 7

This question was generally well answered with most candidates obtaining the majority of the marks.

(d) Air is excluded from the apparatus to prevent the oxidation of Fe^{2+} or Fe(II) ions to Fe^{3+} or Fe(III) ions by oxygen.

Answers must include the correct formulae of the ions involved.

An answer suggesting that air oxidises iron is not acceptable.

In the test for hydrogen candidates must mention the presence of a flame.

(d) When errors occur in the burette readings or in subtracting the volumes, the mean must be taken from the two closest titres.

A common error is to use titres 2 and 3 irrespective of the any of the aforementioned errors.

(e) – (i)

As usual any error may be carried forward and, if used correctly in subsequent parts, may gain marks.

In all cases answers must be correct to a minimum of three significant figures except when the third figure is a zero.

Question 8

This question involves the analysis of aluminium sulfate, $Al_2(SO_4)_3$ and was generally answered well. In **(a)** a colourless solution is obtained. Colourless compounds, solids and precipitates are not acceptable. In **(d)** any mention of a sulfate or sulfuric acid as a test reagent loses all the marks for test. An incorrect formula for aluminium sulfate was frequently seen.

Question 9

Parts **(a)** to **(c)** and **(e)** were generally answered well.

(d) Most candidates completed the third column of the table correctly.

Candidates are asked to plot the total increase in mass against time on the grid. The points should then be connected by two straight lines which, on extension, cross at point t = 45 minutes.

However several candidates introduced one of the following two errors:

Since the lines do not meet at a plotted point, some candidates changed all the increases of 2.25 g to 2.50 g in the table which on plotting produce two lines which meet at point t = 50 minutes without the need to extend either line.

Instead of extending each line, the points at t = 40 and t = 50 minutes, some candidates joined the lines by a third short line or a small curve.

Candidates who introduced either of the above errors lost one or more marks but parts **(iii)** and **(iv)** could still score marks consequentially providing that the graph is read correctly.

(f) On using copper electrodes the concentration of Cu^{2+} ions in the solution remains constant.

Thus the mass of the cathode will continue to increase at the same rate as before.

Candidates are asked to draw a line on the graph to represent this.

To gain the mark, the initial sloping line should be continued to reach the top right han[d] ... the grid.

Any variation of this or failure to completely extend the line or not labelling the line loses the mar[k].

(g) Most candidates were aware that the colour of the electrolyte is unchanged at the end of the experiment but many candidates were unable to explain why the concentration of Cu^{2+} ions or the copper(II) sulfate solution is unchanged.