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Paper 5070/11
Multiple Choice

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

General Comments

Questions **4**, **10**, **23**, **36**, and **38** were successfully answered by the great majority of the candidates and the rest of the questions proved to be a good test of the ability of the examination entry.

Comments on Specific Questions

Question 7

A similar proportion of candidates chose option **D** to those who chose option **C**. This split was due to confusion over the solubility of aluminium hydroxide in weak and strong alkalis.

Question 8

Sodium chloride can conduct electricity as it is an ionic compound. It does not contain either atoms or molecules.

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Question 16

The key to this question is the realisation that bond breaking is an exothermic process and bond making is an endothermic process.

Question 21

This was a simple recall question.

Question 26

Aluminium was the most popular incorrect answer. All metals always form ions by losing electrons and not by gaining electrons.

Question 28

Silver and copper are both below hydrogen in the reactivity series and do not react with water, therefore the correct answer was **C**.

Question 31

Options **B**, **C** and **D** all contained sulfur dioxide. Since no sulfur compound is involved in the electrolysis of molten aluminium oxide, all of these options were incorrect.

Question 35

The molecular formula of butanoic acid is $C_4H_8O_2$ and once written in this form it is much easier to see that this can be simplified to the empirical formula C_2H_4O. Thus the molecular and empirical formulae of butanoic acid are not the same.

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Paper 5070/12
Multiple Choice

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

General Comments

A number of questions had very high success rates but all of questions discriminated well.

Comments on Specific Questions

Question 7

Liquid propane has the molecular formula C_3H_8 and propane gas also has the molecular formula C_3H_8. This means that no covalent bonds are broken when propane changes physical state and the most popular answer, **B**, to this question was incorrect.

Question 12

The process of balancing equations uses the fact that the mass of the reagents for a reaction equals the mass of the products of the reaction.

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Question 14

The word '**always**' in the stem of the question was vital to obtaining the correct answer and distinguishing between the options **A** and **B**.

Question 18

Statement '2' in the question was thought by many candidates to indicate acidity. Barium nitrate will form a white precipitate with any sulfate and not just sulfuric acid.

Question 23

Helium is the one exception to the statement that all noble gases have eight electrons in their outer shell.

Question 36

In all addition reactions there is only one product and the second most favoured answer, **A**, was a substitution reaction.

Question 37

In a fully displayed structural formula, all the bonds between the atoms are shown. The bond between the O and the H in option **D** was missing and the correct answer was **A**.

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Paper 5070/21

Theory 21

Key Messages

- Candidates would benefit from more practice in writing and balancing unfamiliar equations when sufficient information is provided as well as in the construction of ionic equations.
- A greater use of scientific terms is required when writing extended prose in questions about environmental aspects of chemistry including recycling and fuel cells. Vague statements such as 'saving the environment' and 'eco-friendly' will not gain credit.
- In question involving equilibrium reactions, a clear distinction needs to be made between questions involving rate and questions involving extent and direction of the equilibrium.
- Calculations, especially in ***Section B***, were done well by many candidates. Others need to take care with the application of significant figures and ensure accuracy when dealing with large numbers.
- Many candidates need more practice at answering questions about practical aspects of chemistry, for example, salt preparation.

General comments

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 found the short answer questions less challenging than those which required extended answers. Good answers used the correct chemical terms. Some candidates gave imprecise and vague extended answers. These candidates could be advised to use bullet points rather than writing in paragraphs.

Candidates often did not organise their answers to quantitative questions which makes it difficult to award marks for errors carried forward. Candidates also found using units such as tonnes or kilograms much more difficult than those in grams.

Comments on specific questions

Section A

Question A1

Most candidates attempted these questions.

(a) Many candidates recognised ammonia as an alkaline gas.

(b) Ethene was the most popular correct answer and only a small proportion of candidates gave sulfur dioxide.

(c) Many candidates gave carbon monoxide rather than oxygen.

(d) Neon was well known as a monatomic element.

(e) Although sulfur dioxide was recognised by some candidates many chose the other gases listed in the stem.

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(f) Most candidates recognised chlorine as the element that is used to sterilise water.

(g) Many candidates recognised nitrogen and carbon monoxide.

Question A2

Some candidates experienced difficulty interpreting the data given in the stem.

(a) (i) A significant proportion of candidates did not attempt this question although some recognised that the gas was SO_2.

(ii) Candidates were often able to calculate the empirical formula of the gas as SO_3.

(iii) Only a small number of candidates recognised steam as the gas. The mark scheme allowed water.

(iv) Some candidates recognise Fe^{3+} but a common error was Fe^{2+} or just stating iron without specifying the oxidation state.

(b) (i) Candidates did not always recognise iron(II) hydroxide and sometimes gave the name of the metal or just iron hydroxide.

(ii) Candidates found this question very difficult and even if the formulae were correct the state symbols were often wrong, in particular giving $Fe(OH)_2(aq)$.

Question A3

This question focused on iodine and the other halogens.

(a) Candidates often appreciated that iodine has no free electrons. Comments about no free ions were ignored since although true are not relevant.

(b) Candidates were not always able to clearly express their ideas about kinetic theory. Candidates often referred to bonds broken without being clear that it was the intermolecular attractions that were overcome. Candidates also did not appreciate that the particles gain kinetic energy and begin to move faster.

(c) Many candidates could draw the 'dot-and-cross' diagram for an iodine molecule. The most common errors involved having multiple shared pairs of electrons rather than just one shared pair between the iodine atoms.

(d) (i) Candidates often stated that the astatide ion was At^-.

(ii) Candidates could often recall two of the entries in the table but seldom all four. The colour of iodine at room temperature was not well known and often the colour of aqueous iodine was described.

(iii) Many candidates just gave the state of astatine rather than the state and its colour.

(e) (i) Many candidates could not describe the colour change in the displacement reaction. The formation of a purple colour was often given.

(ii) The ionic equation was not well known by candidates and many candidates wrote equations without ions that were not balanced.

(f) The idea that astatine was less reactive than iodine was well known.

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Question A4

(a) (i) Candidates very rarely got full credit in this question. They often found the electronic configurations of the ions more demanding that the number of subatomic particles.

(ii) Candidates often gave very good accounts of how a magnesium ion and an oxide ion were formed.

(b) Candidates did not refer to the structure of magnesium oxide being giant even when they described the strong attraction between positive and negative ions. Many candidates gave contradictory ions referring to ions and covalent bonding or intermolecular forces.

(c) Candidates very rarely were awarded full credit for the question. Even those who described the formation of a precipitate that was filtered off did not clearly explain how the precipitate was dried. Common misconceptions involved the use of titration or that the filtrate contained a solution of barium sulfate.

Question A5

This question focused on displacement reactions of metals.

(a) Candidates either gave the correct order or gave the reverse order. A small proportion of the candidates gave the names of the solutions instead.

(b) Only a small proportion of the candidates could give two correct observations. The colour of the copper and/or iron(II) sulfate formed was not well known.

(c) (i) The term exothermic was well known by candidates.

(ii) Most candidates could not construct the ionic equation and either left it blank, or wrote down the wrong formulae.

(d) The presence of the impermeable layer of aluminium oxide was not well known and often explanations related to the temperature of the water not being high enough.

(e) Only a small proportion of candidates could calculate the correct answer of 0.5625 tonnes. Answers in grams were given full credit. A common misconception was to use the atomic number of molybdenum rather than the relative atomic mass. Other candidates used the mole ratio in the equation with the mass of aluminium getting an answer of 2 tonnes of aluminium.

Section B

Question B6

This question focused on seawater.

(a) Many candidates could use the formulae of the ions to deduce the formula of a salt. The most common answer was $NaCl$.

(b) Many candidates did not get the correct answer of 0.276 mol dm^{-3} because they either did not attempt the question or they did not use the relative formula mass of the SO_4^{2-} ion.

(c) Candidates often found this calculation difficult and did not get the correct answer of 1.92 g. Many candidates were unable to calculate the mass or moles of chloride ion in 25 cm^3 and as a result could not deduce the mass of silver chloride being made. Many answers did not involve the relative formula mass for silver chloride.

(d) Distillation was the most popular answer but desalination was also seen.

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(e) (i) Some candidates appreciated the link between the pH of seawater and the presence of hydroxide ions. Other candidates just chose one of the ions in seawater and stated that this ion reacted with sea water to give an alkali.

(ii) The use of universal indicator to estimate the pH was often poorly expressed with candidates not mentioning the link between the colour obtained and the pH value. Other candidates used acid-base indicators such as methyl range which are of very limited use to determine the pH of a solution.

Question B7

This question focused on the homologous series of carboxylic acids.

(a) The term homologous series was quite well understood but a common error was to refer to a group of elements rather than compounds. The idea of similar chemical properties as well as having a general formula was well known.

(b) Many candidates were able to deduce that the name was butanoic acid.

(c) While many candidates drew structures showing all the bonds and all the atoms they often drew the carboxyl group incorrectly having a carbonyl bond that had an oxygen atom bonded to a hydrogen atom.

(d) Many candidates could write the molecular formula for heptanoic acid a small proportion included COOH in the structure.

(e) Candidates often mentioned that there was a trend in the boiling points of the carboxylic acids, some candidates did not mention that the lack of a real trend for the melting points.

(f) Candidates had more difficulty writing appropriate equations than describing in words the difference between a weak and a strong acid. Candidates very rarely showed the equation with ethanoic acid with an equilibrium sign rather than an arrow.

(g) Only an extremely small proportion of the candidates were awarded credit for this question. Many were not able to write the formula for calcium ethanoate and as a result could not access the credit available for the state symbol.

Question B8

This focused on sodium hydroxide.

(a) Some candidates appreciated that a hydroxide ion has 10 electrons. A common incorrect answer was 8 electrons.

(b) Candidates often appreciated that sodium hydroxide solution had mobile ions but solid did not. Other candidates referred to electrons as the charge carriers.

(c) Although candidates often described oxidation and reduction correctly they were less able to identify which equation exemplified oxidation and which reduction. A common misconception was that electrons on the right hand side of an equation illustrated electron gain.

(d) (i) There has been an improvement in answering this type of question but many candidates still believe that bond forming requires energy. Centres should advise candidates to answer in three sentences rather than trying to write a complex explanation in one sentence.

(ii) Only a small proportion of candidates were able to get the correct answer of 3750 g. Candidates often did not use the correct mole ratio appreciating that 2 mole of oxygen make one moles of oxygen.

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Question B10

(a) Candidates did not always clearly state what happens to the position of equilibrium or even made contradictory statements. Good answers linked the endothermic nature of the reaction with the position of equilibrium moving to the right.

(b) Some candidates did not appreciate that the question was about rate of reaction and continued to use le Chatelier's principle. Candidates did not often refer to more particles per unit volume or that the collision frequency had increased.

(c) Candidates often only gave one reason and did not focus on both the increase in the rate of reaction and the fact that lower temperatures or lower pressures could be used without compromising the rate.

(d) Many candidates did not get the correct answer of 35000000 kJ. A significant proportion of the candidates gave answers that showed they had not appreciated that the mass was given in kilograms and not grams.

(e) Candidates could not recall the details of margarine manufacture and often left out the need of a nickel catalyst or high pressure. They also did not mention the use of unsaturated fats.

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Paper 5070/22
Theory 22

Key Messages

- Candidates would benefit from more practice in writing and balancing unfamiliar equations when sufficient information is provided as well as in the construction of ionic equations.

- A greater use of scientific terms is required when writing extended prose in questions about environmental aspects of chemistry including recycling and fuel cells. Vague statements such as 'saving the environment' and 'eco-friendly' will not gain credit.

- In question involving equilibrium reactions, a clear distinction needs to be made between questions involving rate, and questions involving extent and direction of the equilibrium.

- Calculations, especially in ***Section B***, were done well by many candidates. Others need to take care with the application of significant figures and ensure accuracy when dealing with large numbers.

- 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 and scored well in ***section A***. Most candidates performed less well in ***section B***, especially those choosing **Questions 7** and **9**.

Aspects of inorganic chemistry were generally well answered. The writing of balanced equations was not always successful, a major obstacle for some candidates being to work out the formula of simple species such as zinc hydroxide and calcium nitrate. Ionic equations provided particular difficulties. More practice is required in constructing these.

Practical aspects of chemistry e.g. **Questions A2(a)** and **(b)** (analysis of zinc), and **B7(e)(ii)** (preparation of the salt copper chloride), posed challenges for many candidates. The answers to the latter were often written in a confused manner with little idea of the nature of the salt. Good answers were seen in **Questions A1**, **A4** and **B8**.

In general, ***section B*** questions were not as well answered as those in ***section A***, the question on equilibrium and rate aspects of methanol formation, **B9**, proving the most demanding of these.

Candidates often lost credit on questions which required extended prose e.g. **A3(a)**, **A3(e)(ii)**, **B6(b)** and **B9(a)** and **(b)**. The rubric was not always well interpreted, e.g. in **Questions B6(d)**, **B7(a)(ii)** and **B8(g)(i)**.

The majority of candidates attempted most parts of each question in ***section A***. The exceptions, where a significant number of candidates did not respond, were **Questions A2(a)(ii)** which required the writing of an ionic equation, **A2(c)(ii)** requiring the proof of the formula NO_2 and **A3(d)(ii)** where the amide linkage was often not drawn. **Question A2(a)** and **(b)** posed problems for many candidates, particularly because few could identify the metal **X** as zinc.

In ***section B*** most candidates gave answers of the appropriate length to questions involving free response. The standard of English was generally good. In ***Section B***, **Question B9** was the least popular. Some candidates disadvantaged themselves by writing vague or not very scientific answers. This was especially apparent in questions on environmental chemistry, e.g. **A3(a)** and **(c)** and **A4(d)**.

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Some candidates', knowledge of structure and properties in terms of atoms, ions and electrons was fairly good. Some candidates were able to explain the lack of electrical conduction in sand but fewer could give a well-reasoned explanation for its high melting point. Many could write electronic structures of ions (CaO) and molecules (carbon dioxide). Others did not use the idea of completely filled outer shells when constructing their diagrams.

Many candidates performed fairly well on the main question about organic chemistry (**Question B8**). Fewer successfully answered the organic chemistry parts of **Question B9**. Many candidates performed well in questions involving calculations. Many showed appropriate working and clear indications about what each number referred to.

In order to gain appropriate credit, candidates should make it clear why they are performing certain steps, rather than writing a mass of figures. Many relatively low scoring candidates were able to gain full credit for some of the calculations.

<u>Comments on specific questions</u>

Section A

Question A1

This question was the best answered on the paper. Most candidates scored a good proportion of the available credit. The greatest number of errors was seen in parts **(a)** and **(f)**. Most candidates gave full symbols with relevant numbers.

(a) Most candidates correctly recognised oxygen-17. Some gave the oxide ion rather than the oxygen atom. A small number gave the Be isotope, confusing mass number with number of electrons.

(b) Many candidates chose one of the positive ions, Ca^{2+} being the most popular correct response. A small number of candidates gave either negative ions, especially Cl^{-} or listed several ions.

(c) Most candidates correctly chose C-14. The most popular misconception was to suggest Si^{4-}, through any Group IV species would be acceptable.

(d) Most candidates chose one of the correct species. C-14 was chosen far more often than O^{2-}. A few candidates did not gain credit because they showed the oxygen without a charge.

(e) Nearly all candidates recognised that neon had 10 protons.

(f) Many candidates correctly identified calcium as having four completed electron shells. A common error was to suggest K^{+}. A few candidates listed a number of different species.

Question A2

Few candidates scored more than half of the available credit for this question. Many did not realise that the first part of the question was about zinc and few could construct a balanced ionic equation. Many candidates could calculate relative formula mass. Fewer were able to calculate an empirical formula by using mole ratios.

(a) (i) Fewer than a third of the candidates realised that the white precipitate was zinc hydroxide. A minority suggested aluminium or silver hydroxide. Most candidates wrote down the name of a metal rather than a metal hydroxide. Zinc was the most common incorrect answer seen. Aluminium and silver were also frequently suggested. A number of candidates suggested compounds such as metal oxides or sulfates.

(ii) Very few candidates were able to construct a balanced ionic equation, and consequently few obtained credit for the state symbols. A common misconception involved writing an equation to form zinc ions from zinc rather than other way round. This was perhaps because zinc was the answer to **(a)(i)**. Even candidates who got the correct ions in the equation often did not balance the equation, or gave the formula for zinc hydroxide as ZnOH. Many candidates suggested that the zinc hydroxide was in solution or that the zinc ions on the left hand side of the equation were solid.

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(b) Many candidates did not appreciate that the answer was a metal and the corresponding nitrate. Many suggested that the metal was a metal oxide or another metal compound. A considerable number of candidates obtained credit for error carried forward for the corresponding nitrate of an incorrect metal.

(c) (i) Over half the candidates were able to calculate the relative formula mass of nitrogen dioxide. All the numerical answers quoted in the mark scheme were seen.

(ii) A significant proportion of the candidates did not show their working or gave confused working. It was clear that many had not used the information provided and just recognised NO_2 as being an appropriate brown gas. A small proportion worked out the formula rather than the relative formula mass. Those candidates who gained full credit invariably calculated the mole ratio first. Some divided by the molar masses of nitrogen and oxygen rather than the atomic masses. Others used the correct method of working then tried to get a perfect ratio of nitrogen to oxygen rather than deducing a ratio of simple numbers. These candidates ended up with incorrect answers such as $N_{11}O_{22}$.

Question A3

Some candidates gave good, detailed answers to many parts of this question. The best candidates were generally able to understand the structure of a polyamide, understand why sand has a high melting point and give a reasoned account of why it is important to recycle metals. Others only partial credit available in each of parts **(a)**, **(b)**, **(c)** and **(e)(ii)**. Most candidates recognised an example of condensation polymerisation and that sand does not conduct electricity because it has no free electrons.

(a) Fewer than half the candidates gained full credit. Candidates were more likely to refer to less landfill sites than any of the other marking points. Few mentioned saving energy or a reduction in mining. Many referred to cost without qualification. About half the candidates suggested the idea of conserving resources. Others gave vague statements about resources without mentioning the conservation aspects. Many referred to land pollution or just pollution without further qualification. Many wrote vague statements about 'saving the environment' or being 'more eco-friendly'. A significant minority of candidates who did read the question properly, wrote about how metals are recycled, and gave examples of what these metals are used for.

(b) The majority of candidates could draw the polymer. Common errors included: showing a double bond; lack of continuation bonds; lack of a chlorine atom; drawing two different structures polymerised, e.g. a joint polymer of ethene and chloroethene.

(c) This part was slightly better answered than **(a)**. Most candidates referred to landfill and incineration products. A significant minority referred to drains being blocked or harm done to wildlife through ingestion. Many referred to the formation of toxic gases. Others named these as sulfur dioxide or nitrogen dioxide or did not mention that the plastic has to be burnt to produce the toxic gases or carbon dioxide. Two misconceptions which were more rarely seen were that plastics cause eutrophication and the suggestion that plastics cause diseases (sometimes linked to malaria).

(d) (i) Many candidates recognised condensation polymerisation. The two errors most commonly seen were 'addition polymerisation' and 'esterification'.

(ii) About half the candidates were able to draw the amide link between each box. Common errors were: to draw ester links; to put NH between two boxes followed by CO between the next two boxes; confusion between the N, H, O and C atoms, e.g. C–H and N–O; C–O single bonds rather than C=O bonds. A considerable minority did not answer at all.

(iii) Over half the candidates gave fats as the answer. Others gave one or more examples of a food, e.g. cheese, butter, rather than type of food. Two common misconceptions were to write protein or carbohydrate.

(e) (i) The majority of candidates gave the correct formula of sand as SiO_2. Others counted all the atoms in the diagram given. The incorrect answer, SiO_4, arising from just counting the number of oxygen atoms around each Si atom, was also a common error.

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(ii) Few candidates scored full credit. Candidates often wrote in vague terms and referred to forces between molecules and intermolecular forces. The terms macromolecule or giant covalent structure were often missing. The idea that the covalent bonds present were strong and needed a lot of energy to break them was well known, but often accompanied by misconceptions about intermolecular forces.

(iii) This part was well done, with many candidates referring to the lack of free electrons. Common misconceptions were to refer to a lack of valence electrons or to suggest that there were no ions in the sand yet ions could move when sand is molten.

Question A4

Many candidates scored at least partial credit for this question. Many showed a good ability at writing the balanced equations in **(a)** and **(b)**. The slightly more complex equation **(c)** was not as well deduced because many candidates did not use the information provided in the question. In **(d)** most candidates used the information provided to answer the question. A significant number of candidates were able to construct the 'dot-and-cross' diagram for carbon dioxide.

(a) (i) The majority of candidates could construct a balanced equation for the reaction between nitrogen and oxygen. A significant proportion gave atomic nitrogen or (occasionally) oxygen rather than molecular species and so lost credit. The most common errors were $2N + O_2 \rightarrow 2NO$ and $N + O = NO$

(ii) More than half the candidates gave the correct equation, but some started from N rather than NO or did not balance the equation.

(b) Fewer than half the candidates could construct the equation. A significant proportion wrote SO_2 as an additional reactant. Many did not refer to the stem of the question and gave only one of the acids as a product.

(c) (i) Most candidates recognised carbon dioxide. Calcium sulfate was the commonest error.

(ii) Most candidates gained partial credit for the correct name. Few candidates gained full credit. Many candidates wrote the formula incorrectly as $CaNO_3$. Other common errors were $CaNO_2$ (for calcium nitrite or calcium nitrate) and $CaNO_3$ (generally for calcium nitrate). Most candidates gave calcium nitrate rather than calcium nitrite.

(d) More than half the candidates were able to use the data provided but many did not give the comparative answer when required. Occasional error arose because the candidates just stated how much gas seawater removed without comparison with calcium carbonate. Many candidates also referred to the products dissolved in seawater (nitric and nitrous acid) being useful without thinking that considerable purification from the dissolved salts would be necessary.

(e) About half the candidates scored credit here. Common errors were: not drawing valence electrons in the oxygen atoms; showing extra electrons on carbon atom; drawing a pair of electrons rather than two pairs between the carbon and oxygen atoms; omitting an oxygen atom altogether; drawing six electrons on one or both of the oxygen atoms.

Question A5

Many candidates scored partial credit for this question. The calculation in **(c)** was well done by many candidates and many were able to read correct values from the graph. The commonest errors in writing the equation in **(b)** arose from the use of incorrect formulae. There were many inexact or incorrect answers given for part **(d)** often focusing on rate rather than comparative acidity.

(a) A small but significant proportion of the candidates did not read the graph correctly and gave incorrect answers such as 1.1, 2.2 and 2.4. Others used the alkaline pH and gave the incorrect answer 12.7.

(b) About half the candidates gained credit for the equation. Many did not know the formula for potassium sulfate, the commonest errors being KSO_4. A few gave an ionic equation but few gave an equation showing the formation of $KHSO_4$. A considerable minority put hydrogen as a product.

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(c) (i) Almost all candidates read the volume from the graph correctly.

(ii) Most candidates gained partial credit for this calculation and many gained full credit. Common errors were suggesting a 1 : 1 ratio of potassium hydroxide : sulfuric acid, or incorrect calculation of the concentration of potassium hydroxide. Most were able to calculate the correct number of moles of acid.

(d) Few candidates gained full credit. There were many vague comments about the shape of the graph without specific reference to starting pH. Candidates rarely mentioned the vertical section of the graph or the effect of the type of acid on neutralisation volume. There were a few good answers that did refer to the basicity of the two acids. The majority of candidates were awarded marks for the pH of the solution at the start of the experiment. Other vague comments often seen were comments about the graph being higher and comments about faster reaction rates, e.g. 'with ethanoic acid it takes longer to reach neutralisation because it is a weaker acid'.

Section B

Question B6

Many candidates chose this question and a good proportion gained at least half the available credit. As in previous sessions, questions explaining exothermic reactions in terms of bond breaking and bond making, proved demanding for some candidates. Many candidates wrote confused statements about oxidation and reduction in **(d)**. Many did not refer to the equations given or to the oxygen or hydrogen in these equations. In **(f)**, many candidates gave vague responses to the advantages and disadvantages of fuel cells.

(a) Most candidates gained credit here. Many gave an unnecessarily complex answer which could have served also as an answer to **(b)**.

(b) A significant number of candidates gained full credit. Few scored partial credit. In general, the answers appeared to be expressed in a clearer way compared with similar questions in previous sessions. A large number of candidates wrote incorrectly that bond making requires energy. Other errors included only reference to bond forming with no mention of bond breaking and reference to the difference in the numbers of bonds formed and broken.

(c) Over half of the candidates gave the correct answer. A significant number did not refer to moles of hydrogen and oxygen and simply wrote down the answer.

(d) A minority of the candidates gained full credit. Many did not respond to the information shown in the two half-equations. Common errors were: to muddle up oxidation and reduction; lack of a link between oxidation and reduction and the two equations or lack of a link to the hydrogen and oxygen in these equations; the common misconception that OH^- gained electrons rather than oxygen; many candidates referred to oxidation numbers but many did not state which species was being oxidised or reduced. A considerable minority just gave definitions of oxidation and reduction, often in terms of oxygen loss or gain or hydrogen loss or gain.

(e) About half the candidates gained credit here, the commonest correct answer being 'water'. Cracking was often referred to although many could not be credited because they referred to the cracking of crude oil or petroleum. Others gave reactions more appropriate for laboratory rather than industrial scale, e.g. metal and acid or electrolysis of sulfuric acid. Other common errors included 'from the air' and 'by fractional distillation'. It is clear that many candidates believe that hydrogen is present in the atmosphere.

(f) Few candidates scored more than partial credit for this question. Many gave answers which made it seem that the question was about the use of fuel cells in a spacecraft. Candidates were more likely to give an advantage of a fuel cell rather than a disadvantage. The advantage almost invariably referred to formation of a harmless product. Very few mentioned the direct conversion of chemical into electrical energy. In terms of disadvantages, candidates only rarely referred to pollution problems related to disposal or manufacture. They were more likely to refer to storage problems or explosive nature of hydrogen. These statements were often written in rather a vague way, many just referring to the fact that hydrogen (or more often the fuel cell) was flammable. Many wrote about cost or made comments that fuel cells produce less energy than fossil fuels. Statements of this kind were not credited.

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Question B7

Only a few candidates performed very well this question. As in previous sessions, candidates did not score well on questions involving salt preparation and ionic equations. Many gave good answers to **(a)** and **(d)**. Many candidates, when answering **(c)** referred back incorrectly to **(b)**.

(a) Many candidates gave the correct answer. The commonest incorrect answer was 0.88, obtained by misreading the information in the table. A considerable number of candidates undertook unnecessary mole calculations when simple subtraction would have sufficed.

(b) Under half the candidates gave the correct answer of copper(II) carbonate. Many chose species not present in the table and as many chose magnesium carbonate as chose copper carbonate.

(c) Few candidates obtained credit here. Candidates were more likely to refer to differences in reactivity than to percentage composition of a particular metal atom or carbonate or the amount in moles.

(d) (i) This was generally well done. Candidates mostly gave dot and cross diagrams rather than electronic configurations in the form 2.8 and 2.8.8. Candidates were more likely to gain credit for the charge on the ions than for the electronic configuration. A significant number of candidates did not gain credit because they only drew the outer shell electrons rather than the full arrangement.

(ii) About half the candidates gained credit here. Many did not mention slag or calcium silicate. Common errors included statements that calcium oxide is a reducing agent or vague statements about calcium oxide being used to react with impurities.

(e) (i) Very few candidates could write the correct ionic equation. Candidates often included irrelevant equations or had $CuCO_3$ in the equation. The formula for the carbonate ion was not well known, CO_3^- being the usual incorrect species written. Even when the formula for the carbonate ion was correct, very few realised that they had to balance the hydrogen.

(ii) Most candidates could not describe the preparation of copper(II) chloride crystals. Many candidates did not start with copper carbonate and made no use of hydrochloric acid. Few mentioned the use of excess copper carbonate. Others described a titration and yet others a precipitation reaction. Candidates were more likely to be awarded the credit for heating to saturation than credit associated with making copper chloride. Most ignored the information given in the stem of the question and chose copper or copper oxide instead of copper carbonate. Many candidates thought that the chloride was the residue rather than the filtrate.

Question B8

This was the most popular of the ***section B*** questions and also proved to be the highest scoring question in this section for most candidates. Some parts of this question on organic chemistry were well answered. The answers to others, such as **(d)** and **(g)(i)**, indicated that some candidates were not paying sufficient attention to what was being asked.

(a) Most candidates obtained some of the available credit. Over half the candidates could draw the correct structure for propene. Common errors were: carbon atoms having five bonds; two double bonds; lack of hydrogen on the CH_3 group. Candidates often appreciated that the presence of a double bond made the molecule unsaturated but they often did not refer to the important word ‘only’ when defining a hydrocarbon.

(b) Nearly all the candidates knew the term isomer. Allotropes and isotopes were the most commonly seen incorrect answers.

(c) Most candidates gave the correct formula. The commonest errors were to write $C_{10}H_{22}$ or C_5H_{10}.

(d) Fewer than half the candidates scored credit here. Many only referred to boiling points and did not mention that there was no definite trend in melting points. Negative numbers sometimes posed a problem, with many candidates thinking that boiling point decreases as the number of carbon atoms increases.

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(e) Many candidates appreciated that the alkene was a gas, but a significant minority suggested liquid or solid. Many candidates did not give a correct explanation. Many referred to a low boiling point rather than a boiling point lower than room temperature. Others just stated that 'the first four alkenes are gases', which is not an explanation.

(f) A significant minority gained credit here. Common errors were: not balancing the equation; giving the balance of the products as $2C_4H_{10}$ + $2C_4H_8$; writing the wrong alkane as a reactant; giving the products as $3C_4H_{10}$ + C_4H_8; giving octane as the product.

(g) (i) About half the candidates answered this correctly. Candidates often gave the name, structural formula or displayed formula. Common errors included C_4H_8Br, C_4H_7Br and $C_4H_6Br_2$.

(ii) This was generally well done. Candidates sometimes misinterpreted the question and gave a bromine-related product rather than butanol. A few candidates gave the incorrect answer butenol or butanal.

Question B9

This was the least popular question chosen by the candidates from ***section B***. It was also the lowest-scoring question on the paper. In parts **(a)** and **(b)** many candidates did not read the stem of the questions and confused equilibrium aspects with rates of reaction. In **(d)** the equation for the combustion of methanol was often not correctly balanced, while in **(e)(i)** few candidates selected an appropriate oxidising agent.

(a) Few candidates scored full credit and many did not score at all. Candidates often confused rate with equilibrium and stated that the forward reaction was slower because the equilibrium shifted to the left. Candidates very rarely mentioned more effective or more successful collisions, although some mentioned that the molecules moved faster or had more kinetic energy. A significant proportion of candidates suggested that rate decreased because forward reaction is exothermic. Others did not write about the reaction in terms of particles.

(b) Many candidates had a similar confusion between equilibrium and rate as in **(a)**, and often explained what happened in terms of rate rather than in terms of equilibrium. Only a small number of candidates were able to explain why the equilibrium shifts to the left.

(c) A minority of candidates gained full credit. Many made errors due to the units of mass being in kilograms and as result got only minimal credit. Others did not use the correct mole ratio. Many candidates coupled these errors and so were not awarded any credit.

(d) Few candidates successfully balanced the equation for the combustion of methanol. Common errors were: using methane rather than methanol; not balancing the oxygen molecules; showing the balance of the oxygen molecules as $3O_2$; showing the balance of the water molecules as 2 or $8H_2O$

(e) (i) A minority of candidates chose a correct oxidising agent. The reagents and conditions often seemed to be confused with those needed for the hydration of an alkene or for fermentation. Oxygen was suggested as the oxidising agent by many candidates. Temperatures higher than the allowed range, e.g. 300 °C or 400 °C were often seen.

(ii) A minority of candidates were able to draw the correct structure of methanoic acid. Common errors were: carbon atoms with five bonds; ethanoic acid drawn rather than methanoic acid; amethanol-like structure; structures with two OH groups.

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Paper 5070/31
Practical Test

Key messages

As always, candidates should be encouraged to read the instructions carefully.

In the calculations that follow quantitative experiments like titration exercises, candidates would be well advised to follow the advice offered in the questions.

In qualitative experiments, candidates should be reminded of the importance of recording all of their observations accurately, using appropriate terminology.

General comments

The overall standard was good with many candidates demonstrating capable practical skills in completing both 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) Many candidates were clearly competent in carrying out an acid-alkali titration and scored highly with their accurate titres. Nevertheless, there were a few Centres where the necessary volumetric skills were areas for improvement, as revealed by the wide range of titres recorded.

Candidates obtained full credit, providing their initial and final burette readings were given to 1 or 2 decimal places, recorded at least two titres within 0.2 cm^3 of the Supervisor's value, and then correctly averaged two or more results that did not differ by more than 0.2 cm^3.

While most of the candidates completed the table of results properly, there were some who did not tick any results or ticked only one; and others who, having correctly identified the best results, averaged all the titres regardless of their consistency.

It was those candidates who acted upon the advice supplied in parts **(b)**-**(e)** that were the most successful in securing the credit available.

(b) Many solutions showed the correct use of the molar ratio from the equation and provided answers for the concentration of ethanedioic acid to 3 significant figures. While credit was lost due to answers being insufficiently precise, there were a few candidates who made errors in evaluating their mathematical expressions, e.g. 2(M × 24.7) became 2M × 59.4.

(c) Many candidates obtained credit, some easily by using the answer from part **(b)** as instructed in the question, and multiplying it by 90. There were others who made the process more complicated, usually by working out the mass of the acid in their average titre and then determining its concentration.

(d) While there were a good number of candidates who followed the information supplied and subtracted the answer to part **(c)** from 9.45, there were others who secured the correct answer by more circuitous methods. Some candidates failed to score at all because they chose to subtract the mass of acid in the average titre from 9.45 or divided 9.45 by their answer from part **(c)**.

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(e) There were relatively few candidates who were able to calculate the value of **x** from their results. Calculating the number of moles of water and then dividing this by the number of moles of acid, was generally the most common solution but there were some who chose to calculate the molar mass of the hydrated acid and use that to determine **x**. It is important to remember that there is no credit available for writing an answer, such as 2, if there is no evidence of working.

Question 2

Virtually all the candidates made good use of the time available and completed the question. All the scoring points noted in the Mark Scheme were awarded in the assessment of examination scripts. The most successful candidates carefully followed instructions and recorded observations clearly using appropriate terminology. While others displayed competence at times, they were inconsistent in their approach. Consequently, credit was 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. There is no credit to be gained by simply naming a gas. 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 credit for this question.

R was potassium iodide **S** was hydrogen peroxide

Test 1 Many candidates noted a precipitate was formed in part **(a)** but it was not always yellow – white was a common alternative. Descriptions such as liquid turns milky or cloudy on addition of silver nitrate gained no credit. Credit was given in part **(b)** for any indication that the solid remained when nitric acid was added.

Test 2 The iodine produced by this reaction turns the solution red/brown and many candidates correctly reported this.

Test 3 In part **(a)**, the addition of the dichromate(VI) ions causes iodine to be formed and as a result the liquid turns brown and contains a precipitate. The addition of thiosulfate ions to the mixture in part **(b)** converts the iodine to soluble colourless iodide ions so the solid disappears and the solution remaining is green due to the chromium(III) ions.

While the Mark Scheme allowed for a variety of alternative descriptions to be credited, there were a number of candidates who displayed excellent powers of observation and practical skills by recording accurately and correctly what occurred.

It is important that when a liquid is added to another that they are mixed together thoroughly. There were a number of cases where the solid formed in part **(a)** did not disappear when the sodium thiosulfate was added, despite the solution turning green.

Test 4 1 or 2 drops of **R** to the acidified peroxide causes some iodine to be formed in the solution in part **(a)**. When more **R** is added and the mixture is allowed to stand, solid iodine is produced. Candidates generally scored well, reporting that the solution turned yellow, red or brown in part **(a)** and that a black solid was seen in part **(b)**.

Test 5 Reaction with **S** oxidises the pale green iron(II) ions to yellow iron(III) ions and this change is confirmed in part **(b)** when the addition of aqueous sodium hydroxide produces a red-brown precipitate which is insoluble in excess of the alkali. There were relatively few candidates who noted the insolubility of the precipitate in excess alkali.

Bubbles are seen in part **(a)** and the effervescence is greater in part **(b)** when the alkali is added. While many candidates recorded the bubbling, not all of these went on to test the gas. The gas relights a glowing splint and is therefore oxygen. The correct test and its result are required to score credit and, without some indication of the test, no credit could be earned for naming oxygen.

Test 6 The purple solution turns colourless when **S** is added to it and the liquid bubbles as oxygen is formed by the oxidation of the hydrogen peroxide. Most candidates indicated that the purple colour was lost, if only by stating that the solution remained or even turned colourless but there were occasional answers which incorrectly stated ‘turns clear’ or gave no description of the liquid produced.

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Test 7 In part **(a)**, there is no reaction when copper is added to **S** and numerous candidates either stated this or wrote that the copper was insoluble or sank to the bottom, etc. However, there were answers which indicated that a reaction took place, e.g. ‘a brown ppt forms’ or ‘forms a brown solution’ and these received no credit.

The addition of ammonia to the mixture from part **(a)** produces bubbles of oxygen and the final liquid is blue. While the bubbling was frequently reported, the gas was more often identified as ammonia than oxygen. Few candidates noted that the liquid turned blue.

Conclusions

Candidates who reported a yellow solid, which remained in nitric acid, virtually all successfully identified the anion in **R** as iodide.

The term oxidant or oxidising agent was correctly used by many of the candidates who reported the solution turning yellow in **Test 5(a)** and /or a red-brown precipitate in **Test 5(b)** but there were some who believed that these observations showed **S** was a reducing agent.

The loss of the purple colour in **Test 6** was correctly used to deduce that **S** was a reducing agent. However, there were candidates who used the same observation to conclude **S** was an oxidising agent.

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Paper 5070/32
Practical Test

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Paper 5070/41
Alternative to Practical

Key messages

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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 are examined.

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 successfully using the appropriate number of significant figures, but candidates should be encouraged to show all their working.

On occasions, poor handwriting makes it difficult to read key words in an answer. Care should be taken with the clarity of answers as well as the spelling of chemicals, apparatus and techniques.

It is recommended that candidates are taught the IUPAC chemical names for chemicals as used in the syllabus. Those that attempt to use some of the less common names have been found to be more likely to make errors.

Comments on specific questions

Question 1

(a) The vast majority of candidates recognised the measuring cylinder and were able to read the correct volume of liquid in it.

(b) On a small number of occasions, the volume of liquid was read as 20.4 cm^3 and not 24 cm^3.

Question 2

(a) Several candidates knew that the colour of copper was brown-orange or pink. Some candidates gave the correct colour without mentioning the physical state. Many candidates thought that copper was blue (confusion with copper(II) sulfate) or black (confusion with copper(II) oxide).

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(b)(c)(d) In these three parts, the majority of candidates gave the correct numerical answers.

(e) Most candidates deduced the correct formula. It is essential to show full working in questions of this type. Those candidates who answered that copper forms an oxide with the formula CuO gained no credit where they did not show their working.

Question 3

(a) (i) Bubbling or effervescence or the solid dissolving were the observations that were expected from candidates.

(ii) There were some very good equations. $CaCl$ was the most frequently seen incorrect formula.

(iii) Some candidates realised that a loss of mass would occur. Those who did realise this often made it clear that the loss of mass was caused by the gas evolved <u>leaving the apparatus</u>. Some candidates answered that gases are lighter than liquids or solids, which was why there was a loss of mass.

(b) (i) A white precipitate or a white solid were the only acceptable observations.

(ii) Some very good equations were seen. Br was occasionally used as the symbol for barium instead of Ba. $BaCl$ was the most frequently seen incorrect formula.

(iii) It was clear to some candidates that there was no change in mass because nothing entered or left the apparatus.

Question 4

(a) The name chromatography was quite well known by many candidates.

(b) Some candidates had not realised that the solvent level should be below the start line. If the solvent level is above the start line, the original samples would wash out of the chromatogram.

(c) Only a small number of candidates knew that a capillary tube or dropping pipette were suitable for placing spots on the start line of a chromatogram.

(d) Dyes and indicators were the most common answers to this question. A locating agent is the only acceptable general name given for a substance which is used to make colourless spots visible on a chromatogram.

(e)(i) The majority of candidates knew that substances **M**, **N** and **P** were present in mixture **X**.

(ii) The majority of candidates knew that substances **L** and **P** were present in mixture **Y**.

(f) A number of candidates successfully calculated the R_f value of **P** by dividing the distance travelled by **P** (2.5 cm) by the distance travelled by the solvent (5.5 cm) and obtaining the answer 0.45 cm.

Candidates are advised to make an attempt at all the multiple choice questions on these papers. There are no deductions for incorrect answers.

Question 5

A large numbers of candidates correctly realised that if a gas is to be dried the delivery tube should pass below the liquid level of the drying agent, but the emergent tube should not be below the liquid level.

Question 6

The ester is made from a carboxylic acid with three carbon atoms (seen on the left hand side of the formula of the ester), which is propanoic acid and an alcohol with three carbon atoms (seen on the right hand side of the formula of the ester), which is propanol. The correct answer was **(b)**.

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Question 7

The apparatus shown is used to produce nylon, which is the only polyamide listed. The correct answer was **(a)**.

Question 8

Large numbers of candidates knew that C_4H_8 was unsaturated, recognising that the general formula of alkenes was C_nH_{2n}. The correct answer was **(c)**.

Question 9

In an endothermic reaction, the temperature of the reaction mixture falls and then returns to room temperature. The correct answer was **(b)**.

Question 10

(a) The majority of candidates calculated the correct mass.

(b) The majority of candidates knew the correct equipment to complete this transfer.

(c)(i)(ii) The colours of methyl orange which were yellow originally, changing to orange (although red or pink were accepted) at the end-point of the titration were known by some candidates, although it was not uncommon to see the colour change given the wrong way round.

(d) The reading of the burettes, the completion of the table and the selection of the closest readings to calculate the average volume were usually carried out correctly by candidates.

In **(e)** through to **(j)**, any error in one part of the calculation may be carried forward and used in subsequent parts of the calculation and, providing that no further errors are made, the remaining credit may be awarded. Most candidates gave correct titres and were able to complete most or all the calculations.

(k) Candidates were expected to answer that **x** in the formula had to be a whole number and thus were expected to write the correct formula in which **x** was rounded up or down to the nearest whole number. Answers which were consequential on previous errors were allowed up to full credit. Although for example, the value of 625 may have been consequentially correct, such a high number should have prompted candidates to realise that they must have made an error in an earlier stage of the calculations, in which case they should have reviewed their answers.

Question 11

(a) Many candidates realised that as the solution is probably not a compound of a transition metal, the solution would have been colourless.

(b)(i)(ii) The white precipitate indicated Al^{3+} Zn^{2+} or Ca^{2+}, but it dissolved in excess aqueous sodium hydroxide which meant that the solution must contain Al^{3+} or Zn^{2+}.

(c)(i)(ii) Because candidates were told that the solution contained Al^{3+} as the cation, this meant that it produced a white precipitate which was insoluble in excess aqueous ammonia.

(d) The test for nitrates was known by some candidates.

The brown ring test was given as an acceptable alternative to the aluminium and sodium hydroxide test by a small number of candidates.

(e) The correct formula of aluminium nitrate was given by a minority of candidates.

Question 12

(a) The table was almost always completed successfully by candidates.

(b) The points were almost always plotted correctly and a smooth curve drawn by candidates.

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(c) Some candidates extended the curve successfully and read the correct volume of hydrogen from the value of $A_r = 88$.

(d) Many candidates incorrectly answered that the volume of hydrogen was related to the reactivity of the metal. Some referred to the rate of reaction.

(e)(i) The majority of candidates answered that the volume of hydrogen was in some way related to the reactivity of aluminium. Some thought that the difference in volume was due to experimental error. Some excellent equations were seen for the reaction between aluminium and hydrochloric acid. These achieved full credit because they illustrated the mole ratio between aluminium and hydrogen.

(ii) Some candidates incorrectly answered that the initial temperature must have been low, but then suddenly increased.

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Paper 5070/42
Alternative to Practical

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Calculations are generally completed successfully using the appropriate number of significant figures, but candidates should be encouraged to show all their working.

On occasions, poor handwriting makes it difficult to read key words in an answer. Care should be taken with the clarity of answers as well as the spelling of chemicals, apparatus and techniques.

It is recommended that candidates are taught the IUPAC chemical names for chemicals as used in the syllabus. Those that attempt to use some of the less common names have been found to be more likely to make errors.

Comments on specific questions

Section A

Question 1

(a) The diagram shows a pipette.

(b) (i) A safety bulb should be used to draw the liquid into the pipette.

(ii) Without this apparatus a candidate would have to use his or her mouth to suck the liquid into the pipette resulting in the possibility of harmful liquids entering the mouth.

Most candidates were aware of this need but many were unsure of the name of the apparatus.

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Question 2

(a) (i) The apparatus is a condenser and it is used to ensure that unreacted alcohol is returned to the flask to continue the reaction. It should be noted that the question asks why it is used in this reaction, thus a general answer suggesting the conversion of vapour to a liquid was not acceptable. In similar questions candidates should not involve the word condensing in explaining the use of a condenser.

(b) (ii) Ethanol, C_2H_5OH, is used to produce ethanoic acid. Two suitable oxidising agents are potassium dichromate(VI) (colour change orange to green) and potassium manganate(VII) (colour change purple to colourless).

The spelling of dichromate, permanganate and manganate were often not close enough to gain credit. When included, the oxidation states were generally correct,

A water bath should be used for heating as ethanol is flammable. Many candidates suggested the careful use of a Bunsen but this was not acceptable in the presence of ethanol.

(c) (i) Universal Indicator is yellow or orange in ethanoic acid and red in sulfuric acid.

(ii) The reaction of magnesium with both acids produces a number of observations including the evolving of a gas or effervescence and the dissolving or disappearance of magnesium dissolves.

Candidates should then suggest that the reaction of magnesium with sulfuric acid is faster than with ethanoic acid because sulfuric acid is a stronger acid than ethanoic acid.

To gain full credit candidates must compare the strengths of the two acids.

(d) The organic product is ethyl ethanoate, $CH_3COOC_2H_5$, which is a member of the ester series. The incorrect spelling of ethanoate was penalised.

Question 3

(a) Barium sulfate appears as a white precipitate or solid. The three steps are filtration of the precipitate washing with water and drying the precipitate. Many candidates, having correctly described the appearance of barium sulfate, suggested how the filtrate could produce crystals.

(b) Having calculated the number of moles of barium nitrate and sodium sulfate, candidates should use the equation to suggest the number of moles and hence the mass of barium sulfate produced.

Questions 4 to **8**, the multiple choice questions.

Most candidates suggested correct responses to most of the questions. **Question 6** appeared to give the most difficulty. In this question candidates should note option **(b)** in which the initial solvent level is below the level of the sample of ink, but covering the lower part of the paper.

Question 9

(a) 2.69 g of the metal hydroxide is weighed out and made into the solution.

(b) The indicator methyl orange changes from yellow to orange or red.

(c) Candidates should read the burette diagrams and complete the table. If a candidate misreads any of the burette diagrams giving different titres, the mean value should be taken from the two closest titres.

Most candidates gained most of the available credit in this question.

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Question 10

(a) A colourless solution is observed. Mention of any colour, a solid or a compound lost credit.

(b) A white precipitate is observed which is insoluble in excess.

(c) Either of the observations, no precipitate or a slight white precipitate gained credit.

In similar tests candidates should always suggest a positive observation, e.g. no gas evolved, no precipitate or no colour change. The statement that 'nothing happens' or 'no reaction', etc. suggests a lack of knowledge of the particular test and loses credit.

(d) The test for the chloride ion involves the addition of aqueous silver nitrate and nitric acid giving a white precipitate. No credit was awarded for the use of hydrochloric acid in the test.

The majority of candidates scored well on this question.

Question 11

(a) The correct temperatures, taken from the thermometer diagram, are 56 °C, 35 °C, 24 °C, and 15 °C. Several candidates read the temperatures as 50.6 °C, 30.5 °C, etc. In these cases credit was lost.

(b) Candidates who accurately plotted the points on the grid, connected them with a smooth curve, and continued the curve to meet the *y*-axis gained full credit.

Candidates who misread the temperatures as 50.6 °C, etc. must plot these points as 50.6 °C etc. on the grid to gain the plot mark.

Candidates who distorted the curve to meet the *y*-axis at zero or horizontally from their lowest plotted point lost credit.

Candidates who joined points using a series of straight lines lost the curve mark.

(c) The solubility at 0 °C is 20 and at 40 °C is 60 g / 100 cm^3 of water.

(d) Candidates should read the temperature at which the solubility is 70 g / 100 cm^3 of water to suggest the lowest temperature at which 50 cm^3 will dissolve 35 g of sodium nitrate.

(e) Candidates should read the solubility at 50 °C and subtract this answer from 150 g to find the mass of sodium nitrate that will crystallise out from the solution.

In answers **(c)**, **(d)** and **(e)** the candidate's graph was used to determine whether their answers are correct.

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