CHEMISTRY

Paper 5070/11
Multiple Choice

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

General Comments

The number of words in the stem of a question is kept to a minimum and consequently candidates are encouraged to read every word carefully.

Comments on Specific Questions

Question 7

When an ionic compound dissolves in water only the ions become free to move. Only the ions in the ionic lattice are set free and no electrons.

Question 9

The word only, in the question, was missed by many candidates and consequently **B** was often selected as the answer**.**

Question 12

The identity of the electrodes in this question was a vital piece of information and had to be used in order to rule out statement 2.

Question 18

The formation of sulfur trioxide is an exothermic reaction and thus the decomposition of sulfur trioxide is an endothermic process. Therefore an increase in temperature will favour the reverse reaction and less sulfur trioxide is formed, ruling out option **C**.

Question 25

The gas sulfur dioxide turns orange potassium dichromate(VI) green. The popular alternative **A** had the colour change green to orange. Candidates are encouraged to read and think carefully before answering the question. A familiar-looking statement is not necessarily correct.

Question 33

Carboxylic acids react with metals high in the reactivity series. Sodium is very high in the reactivity series and so statement 3 is correct.

Question 37

The hydrocarbon 2-methylpropane reacts with chlorine to produce two isomeric products 1-chloro-2-methylpropane and 2-chloro-2-methylpropane. Thus alternative **D** was incorrect.

CHEMISTRY

Paper 5070/12
Multiple Choice

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

General Comments

The number of words in the stem of a question is kept to a minimum and consequently candidates are encouraged to read every word carefully.

Comments on Specific Questions

Question 8

When an ionic compound is dissolved in water only the ions become free to move. Only the ions in the ionic lattice are set free and no electrons.

Question 15

Photosynthesis occurs in sunlight which provides the energy for the endothermic reaction.

Question 18

The gas sulfur dioxide turns orange potassium dichromate(VI) green. The popular alternative **A** had the colour change green to orange. Candidates are encouraged to read and think carefully before answering the question. A familiar-looking statement is not necessarily correct.

Question 20

The formation of sulfur trioxide is an exothermic reaction and thus the decomposition of sulfur trioxide is an endothermic process. Therefore an increase in temperature will favour the reverse reaction and less sulfur trioxide is formed, ruling out option **C**.

Question 28

Both zinc and magnesium produce hydrogen when reacted with dilute hydrochloric acid. Copper is below and zinc is above hydrogen in the reactivity series and thus hydrogen reduces copper(II) oxide and does not reduce zinc oxide.

Question 30

Statement 3 in the question was incorrect. Any acid with any carbonate produces carbon dioxide.

Question 31

In alternatives **A**, **C** and **D** only one type of change occurs either bond making or bond breaking. In alternative **B** both bond breaking and bond making occur and it is impossible, without the relevant bond energies, to deduce whether the reaction is endothermic or exothermic.

Question 38

When an alkene reacts with bromine the bromine bonds to the two carbon atoms involved in the double bond. Hence **B** was the correct answer.

CHEMISTRY

Paper 5070/21
Theory

Key Messages

To be successful in calculations candidates must organise their answers in a clear and coherent way making certain that the working out is clearly explained.

In terms of structure and bonding candidates must use chemical terms with precision and accuracy.

Candidates sometimes confused collision theory and rate of reaction with equilibria.

Candidates must make certain that they use the correct formula before trying to balance equations.

General Comments

Candidates must make certain that any diagram that is drawn is fully labelled.

Candidates could often define chemical terms with precision but had much more difficulty when applying the use of terms to long questions, in particular those questions related to structure and bonding.

Candidates did not always 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 when an answer is incorrect.

Comments on Specific Questions

Section A

Question A1

(a) **(i)** Many candidates recognised either carbon or silicon.

(ii) Some candidates recognised the element nitrogen but a common misconception was to state phosphorus.

(iii) Many candidates chose potassium although a common misconception was sodium.

(iv) Many candidates recognised nitrogen as an atom having seven protons in its nucleus.

(v) Many candidates chose carbon although a common misconception was oxygen with six electrons in the outer shell.

(vi) The most common correct answer was zinc.

(b) Although some candidates could construct the correct equation, common misconceptions included the use of K_2 and O as reactants.

(c) Candidates often found this question challenging and rarely were awarded both marks. Many candidates referred to the oxide layer on the surface of the aluminium but did not mention that this layer was either inert or impermeable to water and air.

Question A2

This question focused on the properties of the noble gases.

(a) Many candidates in **(i)** and **(ii)** could interpret the data in the table to predict values for the density and boiling point that were within those accepted in the mark scheme.

(b) (i) Candidates often were not able to describe both the arrangement and motion of the particles in argon. The most common correct answers referred to the random nature of both the arrangement and the motion.

(ii) The most common use of argon was as an inert atmosphere.

(c) Some candidates referred to the atoms not needing to gain or lose electrons. Many candidates referred to the presence of a stable octet of electrons but often did not refer to these electrons being in the outer shell.

(d) Many candidates could balance the equation.

(e) Many candidates referred to the difference in boiling points of the components of air but often did not mention that the air has to be liquefied first of all.

Question A3

This question was about chromatography.

(a) Candidates were often unable to draw accurate diagrams. In particular the ideas that the paper is dipped into the solvent and the 'spots' were above the solvent level were not clearly shown. A common misconception was to label the solvent as a solution.

(b) In **(i)** candidates often gave one of the correct metal ions but did not include the second ion. Many candidates in **(ii)** were able to calculate the R_f value quoting a value between 0.68 to 0.70.

(c) (i) Candidates often appreciated that the metal ions were invisible.

(ii) The formation of a blue precipitate was well known but some candidates did not refer to the precipitate re-dissolving on addition of excess aqueous ammonia.

(iii) Candidates found this question very challenging and often could not give the correct formulae for the ions. The mark for the state symbols was only available if the formulae were correct which resulted in many candidates not being awarded a mark for this question.

Question A4

This question was about electrochemical cells, the reactivity series and the structure of metals.

(a) (i) Some candidates gave the correct equation but a significant proportion of candidates included the electrons on the wrong side of the equation or wrote an equation involving the reduction of zinc ions.

(ii) Often candidates did not clearly refer to the last row in the table and gave vague answers about the copper being the negative electrode.

(iii) Many candidates gave the correct answer of silver and magnesium.

(iv) Candidates could often give the correct order of reactivity but did not clearly explain their reasoning.

(b) In **(i)** most candidates did not refer to layers of positive ions being able to slide over each other. A common misconception was to state that atoms or ions could slide over each other. Most candidates in **(ii)** did appreciate the significance of the delocalised electrons in terms of electrical conductivity.

(c) Many candidates referred to sacrificial protection in their answer and did not mention that the tin was a barrier against oxygen and water.

Question A5

This question involved calculations about acids.

(a) (i) Some candidates were able to calculate the number of moles as 0.0012 but a common misconception was to use 24 cm^3 rather than 0.024 dm^3 in their calculation.

(ii) Many candidates gave the answer of 0.0012 moles rather than the correct answer of 0.0024 because they did not appreciate that one mole of the base gave two moles of OH^-.

(iii) Candidates this question very demanding and only the very best answers referred to molar ratio in their answers.

(b) (i) The equation for the reaction of calcium carbonate and hydrochloric acid was often correct.

(ii) Candidates could use the information given to give the correct answer of 0.2 cm^3/s although some candidates did not convert minutes into seconds.

(iii) Only the very best answers referred to a lower concentration of hydrogen ions and to a lower collision frequency. A common misconception was to refer to fewer hydrogen ions. Candidates often referred to ethanoic acid being a weak acid without referring to the partial dissociation of ethanoic acid.

Section B

Question B6

This question was about polymers.

(a) Candidates found this question very challenging. Many answers were imprecise and did not clearly refer to the correct structures, bonding and intermolecular forces. A common misconception was to refer to the stronger intermolecular forces in silicon dioxide. Many candidates did not mention that silicon dioxide had a giant structure or that all of the bonds to be broken were strong covalent bonds. In terms of poly(ethene) many candidates referred to covalent bonds being broken rather than intermolecular forces.

(b) The fact that poly(ethene) is an addition polymer was well known.

(c) Many candidates gave good answers explaining both terms saturated and hydrocarbon. A small proportion of candidates gave good definitions but did not link them to the terms.

(d) Candidates found this question difficult and often gave an answer that was still a polymer rather than a monomer.

(e) Candidates often got one mark for calculating the correct number of moles but they were not able to deduce the correct mole ratio and hence formula, $C_2H_6SiCl_2$, from this data.

Question B7

This question focused on combustion, photosynthesis and respiration.

(a) Many candidates could construct the equation for the complete combustion of propane.

(b) (i) Although many candidates could describe the three processes involved in the carbon cycle most candidates did not then state that the rate of formation of carbon dioxide roughly equals the rate of carbon dioxide loss from the atmosphere.

(ii) Only the best answers referred to the absorption of IR radiation. Some candidates referred to absorption of UV instead. Answers that referred to the consequences of an increased greenhouse effect were not given credit in the mark scheme.

(iii) The source of methane in the atmosphere was well known.

(iv) Candidates found the calculation extremely demanding and only the very best candidates were able to get the correct answer of 9.33×10^{-4} g.

(c) Many candidates in **(i)** gave the answer that the oxygen came from water and carbon dioxide. Candidates could often give the correct particles in an atom of oxygen-18 in **(ii)**.

Question B8

This question focused on the Contact process.

(a) Some candidates could construct the correct equation. The most common misconceptions were that the formula for oxygen was O and the formula for zinc oxide was ZnO_2.

(b) (i) Candidates expressed the idea that the position of equilibrium moved to the right in a variety of ways and often described the forward reaction being favoured. The best answers referred to the number of moles of gas on the product side being less than the number of moles of gas on the reactant side.

(ii) Candidates expressed the idea that the position of equilibrium moved to the left in a variety of ways and often described the backward reaction being favoured. The best answers referred to the reaction being exothermic so the position of equilibrium moves to the left. Some candidates just referred to the endothermic reaction being favoured without specifying that this was the backward reaction.

(iii) Candidates found this question quite difficult and could only access the first marking point about the activation energy being low, but were unable to take the explanation any further. Only the very best answers realised that since the reaction was faster with a catalyst a lower temperature could be used.

(c) (i) Candidates found this calculation extremely difficult and only an extremely small number of candidates got the correct answer of 53.8%. Even the most able candidates struggled to get more than the mark for the formula mass for the calcium sulfate part being 272.

(ii) Most candidates referred to answers specific to all fertilisers in their answers rather than focusing on the large percentage of calcium sulfate in this particular fertiliser.

Question B9

This question focused on the chemistry of bromine and its compounds.

(a) (i) Only the best candidates appreciated the importance of the hydrogen ions in terms of acidity.

(ii) The colour of aqueous bromine was well known.

(iii) Candidates often appreciated that the particles are moving faster or have more energy but only the best answers then referred to more successful collisions. Reference to increased number of collisions was not sufficient for the second marking point in the mark scheme.

(b) Some candidates could construct the equation between bromine and iodide ions. The most common errors involved using monoatomic halogens in the equation.

(c) Candidates found this question very demanding and often only gave the colour change for one of the reactants given e.g. the colour change was purple to colourless and neglecting what happens to the aqueous potassium iodide. Very few candidates attempted an explanation in terms of the redox reactions happening.

(d) The test for unsaturation was well known.

(e) Many candidates could give the correct 'dot-and-cross' diagram. Some candidates did attempt to show the inner electrons but this was ignored.

CHEMISTRY

Paper 5070/22

Theory

Key Messages

Candidates are advised to read all the information in the stem of each question carefully especially where trends are involved and take note of any formulae given relating to balancing equations e.g. CN^-, H^-. The construction of ionic equations needs more practice.

General comments

Candidates often gained good marks in ***Section A*** though performed less well in ***Section B***. Most candidates gave answers of the appropriate length to questions involving free response, others wrote a lot but gave answers which were too vague or not related to the question asked. A considerable number of candidates left some parts of questions from both ***Section A*** and ***Section B*** unanswered.

Some candidates' knowledge of structure and bonding was good. Others showed confusion between ionic and covalent structures in **Question B6 (a)**, often calling the particles in an ionic structure 'atoms' or 'molecules'. Many referred to *inter*molecular forces between ions. The difficulty of layers of atoms sliding in an alloy compared with a pure metal in **Question A2 (d)(iii)** was not well known. In **Question B6 (b)** many candidates understood that ionic conduction is due to the movement of ions. Others thought incorrectly that it is due to the movement of electrons.

Some aspects of inorganic chemistry were well answered e.g. **Question A1 a)** and parts of **Question A2 (a)** and **(b)**. The writing of balanced equations was not always successful, a major obstacle for some candidates being to work out how to construct ionic equations. **Questions A2 (c)**, **A4 (a)** and **B8 (b)** caused particular problems in terms of identifying the ions in the compounds. Candidates should also be encouraged to use the information given in the stem of the question about the charges on the ions concerned as well as information from the Periodic Table.

Most candidates need practice at answering questions involving the rate of reaction of strong and weak acids in terms of the kinetic particle theory e.g. **Question A1 (b)(ii)**. In answering these questions, candidates should be encouraged to refer to concentration of the relevant ions (hydrogen ions) as well as the frequency of collisions. Candidates should also realise that the strength of acids is not the main thing to be considered when acids are titrated with bases. For example in **Question A4 (c)(i)**, it is the amount of titratable hydrogen ions in ethanoic acid and sulfuric acids which is being compared and not the strength of the acids.

Many candidates need practice at distinguishing physical and chemical properties. In **Question A2 (d)(i)** many wrote down chemical properties such as reactivity with water and oxygen instead of relevant physical properties.

Some candidates showed a good understanding of electrochemical cells. Others need more practice at understanding the basic set-up of an electrochemical cell and the importance of the reactivity series in determining the cell voltage (**Question A5 (b)**)

Practical aspects of chemistry as in **Question A3 (a)** on distillation and **Question B8 (c)** on salt purification, posed challenges for many candidates. Many candidates could improve their marks if they consider carefully the different states of the components in each system.

Some candidates performed well in questions involving calculations, showing appropriate working, clear progression in each step of the calculation and clear indications about what each number refers to e.g. 'moles of potassium hydroxide = 0.00675 mol'. Candidates should be encouraged to take this approach which enables examiners to award marks for errors carried forward. Some candidates seemed unsure how to tackle some of the calculations which appeared unfamiliar e.g. **Question A3 (b)(ii)** (calculation of chloride ion concentration), **Question A3 (c)** (calculation of mass of barium sulfate precipitated) and **Question B7 (e)(i)** (calculation of mass of hydrogen cyanide given a 65% yield). A significant number of candidates tried to use the molar gas volume even when gases were not involved.

Comments on specific questions

Section A

Question A1

Candidates generally scored well in part **(a)** of this question, the exception being part **(i)** where many did not read the stem of the question fully. The equation in part **(b)(i)** was often well constructed. In **(b)(ii)**, few candidates gave accurate enough answers in terms of the kinetic particle theory to gain both marks and many did not score at all.

(a) (i) Few candidates could identify a substance which is simple molecular solid at room temperature. Many candidates suggested metals such as zinc or copper. Others did not read the word 'solid' in the stem of the question and gave fluorine, chlorine or bromine.

(ii) Most candidates identified iron as the metal which oxidised to form rust. Copper was the commonest incorrect answer.

(iii) Many candidates correctly identified phosphorus. The commonest error was to suggest nitrogen or arsenic, which have five electrons in their outer shell but do not have three occupied electron shells.

(iv) Zinc was generally given as the correct answer. A few candidates suggested arsenic. A significant minority of candidates suggested one or other of the halogens.

(v) Many candidates correctly identified iron as having a chloride which forms a reddish-brown precipitate with aqueous ammonia. The commonest incorrect answers were copper or zinc.

(vi) Many candidates could identify a colourless diatomic gas. Others did not read the word 'colourless' in the question and suggested one or other of the halogens. A considerable number of candidates also suggested, incorrectly, that carbon is a gas.

(b) (i) Many candidates balanced the equation correctly. The commonest error was to suggest that the formula for arsenic is As_2 or As_3. Other candidates made simple errors in balancing.

(ii) Few candidates scored both marks. Those who scored one mark suggested that ethanoic acid is partially ionised or that hydrochloric acid is fully ionised. Few mentioned concentration of hydrogen ions. Only the very best candidates went on to write about difference in collision frequency. Most only suggested 'more collisions' or thought that a difference in temperature was responsible and wrote about the number of successful collisions.

Question A2

Many candidates were able to extract data correctly in parts **(a)(i)** and **(ii)**. In part **(a)(iii)** few could use the data fully enough to give an acceptable answer to explain the physical state of caesium at 35°C. Many candidates gained the marks for parts **(b)(i)** and **(iii)**. Most candidates did not score a mark for the equation in part **(b)(ii)** because they wrote one or more incorrect reaction products. Many candidates did not know how to tackle part **(c)**. Others did not use the information in the stem of the question.

(a) (i) Many candidates described the general trend in density correctly. A significant number of candidates omitted the direction of the trend i.e 'down the group'. A minority of candidates described trends in melting or boiling point rather than density.

(ii) Most candidates were able to predict the boiling point of potassium from the data in the table. The commonest errors were to suggest very low values e.g. 200°C or values about 900°C.

(iii) Few candidates gained the mark because although many chose the liquid state, most only referred to the melting point. Only a small minority appreciated that 35°C also needed to be lower than the boiling point. A significant number of candidates chose the solid state. Few chose the gas state.

(b) (i) Many candidates described the general trend in reactivity of the Group I elements with water correctly. A significant number of candidates omitted the direction of the trend i.e 'down the group'.

(ii) Most candidates did not gain the mark because they thought that the product was Rb_2O or RbO rather than RbOH. Of those who realised that the correct species was the hydroxide, many wrote the incorrect formula $Rb(OH)_2$. Water was often seen as an incorrect product.

(iii) Most candidates gave a suitable explanation for the term 'exothermic'. The commonest errors were to suggest 'energy taken in' or 'energy of products higher than reactants'.

(c) Few candidates were able to construct the general ionic equation. The commonest error was to write H^+ ions instead of the H^- ions given in the stem of the question. A significant number of candidates did not respond to this question. Many candidates gave the incorrect equation $H^+ + OH^- \rightarrow H_2O$.

(d) (i) Some candidates correctly suggested differences in density or melting point. Few mentioned two relevant physical properties. Others did not gain marks because they either wrote about hardness which was in the stem of the question or wrote about chemical properties instead of physical properties.

(ii) Many candidates gave a correct industrial use of nickel as a catalyst. The commonest correct answer was making margarine. Others made contradictory statements or gave answers which did not relate to the catalytic uses e.g. 'as an alloy' or 'for cars'. A large number of candidates thought that nickel was the catalyst for making ammonia or sulfuric acid.

(iii) Few candidates scored two marks. Those who scored one mark generally referred to the size of the ions. Most candidates did not refer to the ease of the layers of atoms sliding. Many candidates referred to molecules of metals rather than ions or atoms.

Question A3

Many candidates gave an adequate explanation of distillation in part **(a)** but few scored all three marks. In part **(b)(i)** most were able to write the formulae of the ions present in magnesium chloride but in part **(b)(ii)** very few candidates were able to do the calculation correctly. Many candidates knew the test for chloride ions in part **(b)(iii)**. Most struggled with the calculation in part **(c)**.

(a) Many candidates scored a mark for the idea of water condensing in the condenser. Others did not explain this point very well and suggested that the water was cooled in the condenser. The idea of water evaporating and salts being left in the flask was described well by the better candidates. Many just wrote about the process of water evaporating and condensing and did not realise that anything else was required from the question. Very few candidates scored a mark for mentioning the differences in the boiling points between water and salts. Names of apparatus were often wrong and there was also some confusion about whether the water was condensing into the distillation flask or the conical receiver.

(b) (i) Most candidates identified the formulae of magnesium and chloride ions correctly. The commonest errors were Mg^+ and Cl_2^-.

(ii) Very few candidates scored the mark for this calculation. Most forgot that one mole of magnesium chloride contains two moles of chloride ions. A large number of candidates did not respond to this question.

(iii) Many candidates knew the test for chloride ions. Others did not realise that an observation was required and just named the product, silver chloride. Common errors were: to suggest sodium hydroxide as the test reagent; to omit the word precipitate (or solid); to suggest that the precipitate is yellow, green or blue.

(c) Many candidates gained a mark for calculating the moles of sulfate correctly. Others marks proved more difficult to attain.

Question A4

A large minority of the candidates gave the correct ionic equation in part **(a)**. Most candidates scored the mark in part **(b)(i)**. Fewer could do the concentration calculation in part **(b)(ii)**. In part **(c)(i)** very few candidates realised that the question was about the number of hydrogen ions available rather than the degree of ionisation. In part **(c)(ii)** many candidates were able to deduce a correct pH value. Others did not understand whether the acid was being added to the alkali or the alkali to the acid. The environmental chemistry in part **(d)** was not well known and very few candidates scored all three marks.

(a) Many candidates wrote non-ionic equations or mixed equations including both ions and uncharged species in the same compound e.g. $2H^+SO_4$, Na^+OH. Many candidates wrote unbalanced equations. The equation $2H^+ + 2OH^- \rightarrow H_2O$ was the commonest of these.

(b) (i) The volume of acid added was almost always correct.

(ii) Many candidates scored two or three marks for the calculation. Many others scored zero because they used the molar gas volume, 24, in their calculations with no other relevant working. Some scored a mark for the calculation of the moles of potassium hydroxide and some for calculating the concentration. The mark least often scored was for the calculation of the moles of sulfuric acid, the 2:1 ratio seldom being taken into account.

(c) (i) Few candidates realised that the question was about the amount of ionisable hydrogen in ethanoic and sulfuric acid. Most gave answers referring to strong or weak acids or degree of ionisation.

(ii) Many candidates were able to deduce a pH value in the appropriate range. Others did not understand whether the acid was being added to the alkali or the alkali to the acid and therefore gave incorrect pH values such as 9 or 14. Others did not realise that weak acids such as ethanoic acid do not have very low pH values and gave incorrect answers such as 2. A significant minority gave pH 7.

(d) (i) Few candidates scored more than one mark, generally for the mention of sulfur dioxide. Very few scored from the second or third marking points. Most suggested, incorrectly that sulfur dioxide dissolves in water in water to make sulfuric acid. A very small minority mentioned oxidation of sulfur dioxide.

(ii) Most candidates wrote incorrectly about the effects of sulfur dioxide on humans. The answer should have referred to sulfuric acid not sulfur dioxide. The main errors were: vague answers about harming or damaging the skin; skin cancer; death; breathing problems. A considerable number of candidates wrote about effects on the physical world e.g. 'reacts with limestone or 'corrodes metals'.

Question A5

Part **(a)** was generally well done by most candidates but fewer were able to complete the diagram in part **(b)(i)**, deduce the order of reactivity in part **(b)(ii)** or explain sacrificial protection in part **(c)**.

(a) Most candidates gave the correct order of reactivity. The commonest errors were: to reverse barium and magnesium; to put nickel in the wrong place.

(b) (i) The commonest error was to include a cell or battery of cells in the external circuit. A large number of candidates also added other unnecessary components such as lamps to the circuits (although this was ignored when marking). Some candidates drew short circuits or did not draw a complete circuit. A considerable number of candidates did not respond to this question.

(ii) Many candidates correctly identified iron and silver as producing the highest voltage. The commonest error was to suggest iron and copper. Other candidates wrote just one metal, usually either iron or copper.

(c) Most candidates gained a mark for the difference in reactivity of the metals. Few gained marks for the idea of the zinc corroding instead of the iron or the zinc losing electrons in preference to iron, often because they suggested that zinc rusts or just paraphrased the stem of the question e.g. 'the zinc prevents the steel from rusting', or just stated 'sacrificial protection' without explanation. A considerable minority gave incorrect answers based on a layer of zinc over all the metal.

Section B

Question B6

Many candidates wrote a lot in response to part **(a)** though did not always address the question. Many candidates gave incomplete answers to part **(b)**. The structures of the sodium and chloride ions in part **(c)** were drawn well by many candidates. In part **(d)**, the electrode reactions were often not described rigorously enough whilst in part **(e)** many candidates did not balance the equation correctly or gave incorrect formulae for the reactants or products.

(a) Most candidates wrote a lot but this usually did not reflect in the number of marks obtained. Answers fell into two main categories: The first was where nothing was creditworthy because the candidates did not write about structure and bonding. These candidates tended to write about the properties and uses of sodium chloride and chlorine. The second category was where many things were correct but conflicting statements were written. Many candidates discussed ionic bonding but did not recognise the concept of giant structures. Many of those who mentioned strong bonds between the ions also went on to discuss intermolecular forces. Many suggested that there were strong bonds between sodium and chlorine atoms. The mark scored most often was for the idea that chlorine is a simple molecule. Many then contradicted themselves by going on to discuss breaking the covalent bond or breaking the van der Waals' forces/ intermolecular forces between the chlorine atoms.

(b) Many candidates did not gain the mark because they discussed either the liquid with no reference to the solid or the solid with no reference to the liquid. Many candidates referred to free moving electrons instead of mobile ions. Some also referred vaguely to charge carriers.

(c) Many candidates were able to draw the electronic structures of the sodium and chloride ions. Only a minority of candidates drew covalent structures. Common errors included: not drawing the inner electron shells; drawing a single electron on the outer shell of the sodium ion as well as eight electrons on the outer shell of the chloride ion; drawing too many electron shells for the chloride ion.

(d) Many candidates did not specify either the electrode of the ion involved in oxidation or reduction. There was a wide variety of answers and marks. Many did not specify which was oxidation and which was reduction, or, if they did, they either did not say at which electrodes they were occurring or which species were being oxidised or reduced. The processes were clearly understood but many lost marks by incomplete answers. Many just wrote 'oxidation is loss of electrons and reduction is gain of electrons'. Others suggested that sodium reduces and chlorine oxidises. A significant minority of candidates had oxidation and reduction reversed in terms of electrons.

(e) Many candidates did not gain the mark because incorrect formulae for one or more of the reactants or products were given. The commonest errors were N, Cl, H_2Cl and NH_4. A minority of candidates wrote 3C instead of $3Cl_2$.

Question B7

Parts **(a)** and **(c)** were generally well done by most candidates. In part **(b)**, many candidates did not consider the shape of the graph carefully enough to answer the question fully. In part **(d)(i)** many candidates could construct the equation for cracking. In part **(d)(ii)** fewer candidates could explain in sufficient detail why oil companies crack longer chain hydrocarbons. A minority of candidates could calculate the mass of hydrogen cyanide in part **(e)(i)** and only a few could construct the equation for the reaction of hydrogen cyanide with calcium hydroxide in part **e(ii)**.

(a) Many candidates chose 'alkenes' as the correct homologous series. The commonest incorrect answer was 'alcohols'. Many candidates gave specific names e.g. methane instead of the name of the homologous series.

(b) Many candidates scored the mark for the increase in melting points. Very few candidates scored both marks because the non-linear aspect of the graph was missed. A minority of candidates wrote about changes in density or boiling point instead of melting point.

(c) Many candidates gave the correct formula for nonane. The commonest error was to give an incorrect number of hydrogen atoms e.g. C_9H_{18} or C_9H_{19}.

(d) (i) Many candidates gave the correct formula for ethene, propene and hexane. Others wrote hydrogen instead of ethane or gave the formula of hexane as C_6H_{13} or C_6H_{12}.

(ii) Many candidates focused on what cracking is i.e. conversion of long molecules to small molecules instead of explaining why we need more shorter-chain hydrocarbons. Many did not refer to the importance of the products of cracking and so did not obtain a second mark.

(e) (i) A minority of candidates gained both marks for the calculation of the mass of hydrogen cyanide formed. Some candidates scored a mark for the calculation of the moles of methane (31.25 mol). Many candidates wanted to do a percentage yield calculation in a single step e.g. 65% of 500 and so did not score.

(ii) A minority of the candidates constructed the correct balanced equation for the reaction of hydrogen cyanide with calcium hydroxide. Many did not use the information that the formula of the cyanide ion is CN^-. Others seemed not to realise that calcium is in Group II of the Periodic Table and so has ions with a charge of 2+. The commonest errors arose from incorrect formulae, for example, CaCN, CaOH, $CaCN_2$.

Question B8

In part **(a)** few candidates could calculate the mass of ethanoate ions although many could extract information from the graph correctly. Candidates struggled to calculate the average rate of reaction or describe the change of rate with time. Very few candidates could construct the ionic equation for the reaction of aqueous iron(III) sulfate with aqueous sodium hydroxide in part **(b)**. Few candidates were able to describe preparation of pure dry crystals of iron(II) sulfate in part **(c)**.

(a) (i) A minority of candidates correctly determined the concentration of ethanoate ions from the graph but hardly any candidates could calculate the mass of the ethanoate ions in 200 cm^3. A significant number of candidates attempted calculations without using a value from the graph.

(ii) Very few candidates realised that they had to divide the concentration by time and just gave a reading from the graph. A number of candidates used figures well outside the range shown on the graph.

(iii) Most candidates just discussed an increasing rate. The concepts of concentration and rate were often confused. Most candidates thought that rate increased with time and constructed answers around this false premise.

(b) Most equations written were either molecular or involved a mixture of ionic and molecular species. A wide variety of species were seen and some equations did not involve iron(II) or hydroxide ions. A variety of additional products such as hydrogen and water were also seen.

(c) Practical details were not well known. Few candidates recognised that the reaction mixture needed to be filtered before evaporation. Many candidates wrote good descriptions of crystallisation but forgot that the crystals needed to be dried by an appropriate method.

Question B9

Some good marks were scored on this question in parts **(a)** to **(d)** though many candidates wrote vague or contradictory answers especially in part **(c)**. Many candidates confused rate and equilibrium aspects in these questions. In part **(d)**, many candidates were able to calculate the percentage by mass of nitrogen in ammonium phosphate.

(a) Many candidates scored both marks. A significant minority suggested that 'there is a decrease in yield with temperature' i.e. not specifying the *increase* in temperature. Most candidates gave sufficient explanation in terms of position of equilibrium or the reaction being exothermic. Some candidates gave vague answers where it was not clear whether it was the backward or forward reaction that was being referred to.

(b) Many candidates scored at least one mark for the correct trend. Fewer gave an adequate explanation in terms of the position of equilibrium moving in the direction of lower number of moles. Many candidates just discussed the equilibrium moving to the right without explaining why. A few wrote too vaguely and suggested that the yield increased with pressure, not specifying the *increase* in pressure.

(c) Few candidates scored both marks for this question. Many used the numbers quoted in the stem of the question rather than suggesting the effect of higher or lower temperatures and pressure outside this range. Many went on to write that the quoted figures were the optimum conditions or the conditions where the yield is greatest. This was not sufficient to gain marks. Candidates suggested that these conditions gave a higher yield, leaving no suggestion as to whether they thought that the temperatures/pressures were high or low. The better answers discussed rate and yield. The effect of lowering or increasing the temperature and pressure was appreciated by better candidates and those who opted for this route usually scored both marks. A significant number of candidates referred to (botanical) plants, enzymes or fertilisers instead of chemical plants (specified in the question) and therefore gave answers which could not be given credit.

(d) Many candidates realised that catalysts speed up a reaction but fewer obtained the mark for lowering energy costs. The commonest incorrect answers related to saving time, saving money or not having to replace the catalyst so saving money. A significant number of candidates thought that the second mark should relate to an explanation of how catalysts work despite the reference to 'economic advantage' in the stem of the question.

(e) Most candidates understood how to calculate the percentage by mass of nitrogen in ammonium phosphate but the molar mass of ammonium phosphate was often calculated incorrectly. Other common errors included: the use of one or more atomic numbers in place of relative atomic masses; the use of one atom of nitrogen instead of three in calculating the percentage yield; using 4 x PO instead of P + 4O in calculating the molar mass of ammonium phosphate.

CHEMISTRY

Paper 5070/31
Practical Test

Key messages

Candidates would benefit from taking greater care over their volumetric work so that they can achieve better accuracy with their titration results.

Care and consistency is required in the carrying out and reporting of qualitative tests. Instructions should be followed and full use made of the Qualitative Analysis Notes provided.

General comments

While burette readings were generally properly recorded and processed, candidates can improve on the accuracy of their titration results. Few candidates were able to work their way through all parts of the calculations. Qualitative tests were completed but the observations provided were often incomplete and at times incorrect. Supervisors are thanked for providing the required experimental data to enable assessment of their candidates' work.

Comments on specific questions

Question 1

(a) Full marks could be obtained for 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.

Although most of the candidates obtained and selected concordant titres, which they correctly averaged, there were many whose titres were considerably different from the Supervisor's value. A number of candidates carried out unnecessary extra titrations e.g. producing four other titres after achieving concordance with the first two, taking time that could be spent on other parts of the paper.

Candidates showed persistence in attempting all the calculations that followed, thus giving themselves the best chance of securing marks.

(b) This was the calculation most successfully completed. Some candidates lost marks because they did not recognise the 2:1 ratio of thiosulfate to iodine in the equation and others because they could not evaluate their mathematical relationship.

(c) There were relatively few candidates who realised that the answer from **(b)** should be divided by 2. A popular alternative was to divide by 4, suggesting a confusion between iodide ions and iodine. Some ignored the instruction in the question 'Using your answer from **(b)**' and produced much working but usually an incorrect answer.

(d) Candidates who multiplied the answer from **(c)** by 24 often went on to obtain both marks but many either could not use the number of moles of oxygen to calculate a volume of the gas or did not use the answer to **(c)** and evaluated 3 x 100/24.

Question 2

While all the points in the mark scheme were awarded in the assessment of the examination scripts, there were many candidates who found it hard to be consistent in their execution and reporting of the tests. It is important that all the instructions are carefully followed e.g. the amounts specified are used, gases when produced are tested and named. Observations must be recorded accurately using appropriate terminology; teachers are advised to encourage candidates to make full use of the Qualitative Analysis Notes supplied on the last page of the exam paper.

R was aqueous sodium hydroxide **S** was aqueous copper(II) chloride

Test 1

Acceptable colours were generally recorded in both **(a)** and **(b)** but some recorded the formation of precipitates.

Test 2

Many noted the formation of a white solid. There were relatively few who used unacceptable descriptions such as 'liquid turns cloudy' or 'white solution'. The dissolving of the precipitate in an excess of **R** was rarely seen, reinforcing the need to follow the test's instructions.

Test 3

A minority of candidates identified that hydrogen was produced when the aluminium reacted with **R**. The disappearance of the metal and bubbling of the liquid were sometimes observed but many stated that ammonia was produced because the gas was alkaline. It seems likely that candidates turned the red litmus blue by contaminating it with **R** e.g. by putting the litmus paper in the test-tube.

Test 4

Many recorded that a white precipitate was produced in **(a)** and remained when the acid was added in **(b)**. Nevertheless, there were some who reported that the liquid turned milky in **(a)** and others who thought that the precipitate dissolved in **(b)**.

Test 5

Some observations covered all the expected points – a blue precipitate which dissolved in excess ammonia to form a dark blue solution. The rest generally fell into one of two groups: a blue precipitate which remained was presumably the result of not adding an excess of ammonia; a dark blue solution without any mention of solid was the product of adding the ammonia too quickly.

Test 6

While numerous candidates recorded one or more of the observations of colours and the precipitate, when the mixture from test 5 was added to hydrogen peroxide, few noted the bubbling that occurred. Among those who did recognise a gas was produced, some tested it but not all found it to be oxygen and instead suggested carbon dioxide, chlorine or hydrogen.

Conclusions

Of the three marks available in the conclusions, candidates were most successful in identifying the ions in **S**, with slightly fewer scoring the mark for Cu^{2+} than Cl^{-}. Few suggested OH^{-} for the anion in **R**.

CHEMISTRY

Paper 5070/32
Practical Test

Key messages

In qualitative tests, candidates should be encouraged to be consistent in their performing of tests and reporting of observations.

General comments

Overall, candidates demonstrated competency in the required skills and managed their time to complete all parts of the paper. While the titration part of question 1 was carried out successfully by most candidates, the calculations proved more problematic, particularly in parts **(c)** and **(d)**. With the qualitative chemistry, some candidates would have scored more highly if they had been more consistent in their execution and reporting of the tests.

Supervisors are thanked for providing the required experimental data to enable assessment of the candidates' work. In Centres where there are a number of different labs and/or sessions taking place, it may be advantageous to supply Supervisor results for each lab and session.

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 the good accuracy of results found in numerous Centres was particularly noteworthy given the unfamiliar type of titration. While most candidates were well trained in how to complete the table of results, a few confused the recording of the readings e.g. by inverting final and initial readings, using 50.0 for the initial reading or filling one of the rows of the table with the volume of **P** used.

While there were candidates who capably handled all the calculations that followed, many difficulties were encountered. Clear working was provided in almost all answers, enabling candidates to obtain credit particularly when errors were carried forward.

(b) This was the most successfully completed calculation. Errors were generally due to inverting the mole ratio in the equation or ignoring it but there were a few who made mathematical mistakes in evaluating what was a correct relationship – commonly, after cross multiplication, 2 x 25 x c became 2c x 50.

(c) This part proved to be the most difficult. Often the answer from **(b)** was divided by 4 instead of 2, perhaps because the calcium hypochlorite and iodide ions were on the left hand side of the equation or the candidates did not distinguish between iodide and iodine. Some ignored the instruction in the question 'Using your answer from **(b)**' and produced much working but usually the wrong answer.

(d) Successful candidates generally determined the mass in g, by multiplying by 143, and then calculated the percentage. There were also some who determined an apparent relative formula mass, by dividing 10 by the number of moles, which they then compared with 143. Nevertheless, there was a significant proportion of candidates who did not use the answer from **(c)** and chose to divide 10 by 143 before multiplying by 100.

Question 2

All the points noted in the mark scheme were awarded in the assessment of the examination scripts. While candidates generally followed the test instructions, those who did so consistently scored highly providing complete and precise observations. Teachers should 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 aqueous ammonia **S** was aqueous iron(III) chloride.

Test 1 Virtually all the candidates correctly identified and named the gas as ammonia.

Test 2 Most recorded the white precipitate in **(a)** but fewer noted that it dissolved in **(b)** and fewer still that the final solution was colourless. It is important that candidates provide accurate descriptions. No marks are awarded for answers such as 'white solution formed' in **(a)** or 'ppt turns colourless' in **(b)**.

Test 3 A considerable number of candidates only noted the final dark blue solution and made no reference to the initial blue precipitate produced by adding **R**.

Test 4 Most reported the formation of a precipitate but few noted that it was insoluble in excess. The benefits of making reference to the Qualitative Analysis Notes on the final page are evident here and in test 3.

Test 5 The rapid decomposition of hydrogen peroxide takes place when iron(III) hydroxide is added to its solution and the bubbling was recorded by many. The relighting of a glowing splint led most to identify the gas as oxygen but sometimes hydrogen was suggested, presumably because of the vigour of the ignition. There were also a number of candidates who believed the gas to be ammonia.

Test 6 Despite the instruction 'Leave to settle', numerous candidates reported yellow rather than white precipitates in **(a)**. Nevertheless, virtually all found the solid remained when acid was added in **(b)** and so scored the second mark.

Test 7 In **(a)** the addition of sodium thiosulfate to **S** initially produces a deep colouration, which is dark violet, and then the colour quickly disappears. Some missed or did not record the darkening of the colour. Some believed a precipitate was produced. There was much variety in the observations supplied. It may be useful if there is time to repeat a test such as this in order to confirm the findings.

The reaction in **(a)** causes the reduction of iron(III) to iron(II) ions. Consequently, a green precipitate was formed when **R** was added to the mixture which was insoluble in an excess of the aqueous ammonia.

Conclusions

The compound in **R** was generally correctly identified as ammonia or occasionally as ammonium hydroxide. Ammonium was the most common wrong answer provided.

Fe^{3+} was more often given as the cation in **S** than Cl^- as the anion. The problem noted earlier with test 6 led some candidates to suggest I^-.

Those who recognised that the iron(III) ions in **S** had been converted into iron(II) ions in test 7, still had to think carefully before deciding that **S** was 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. When candidates are asked to use their graph to answer a question, the line must be extended if necessary to enable the candidate to read the required answer from their graph.

In answering calculations candidates should always show all of their working. Most questions involve a one stage calculation and are worth one mark. When the number of marks allocated to a calculation is greater than one, 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. In calculations based on titrations answers should be given to three significant figures except when the third figure is zero.

General comments

The Alternative to Practical Chemistry paper is designed to test the candidate's knowledge and experience of practical chemistry. Skills tested include recognition and use of chemical apparatus, reading measurements from diagrams of chemical apparatus, recall of experimental procedures, handling and interpretation of data, drawing of graphs, analysis of unknown salts and calculations using experimental data.

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 drawing lines through the points as instructed. Calculations are generally completed accurately using the appropriate significant figures, but candidates should be encouraged to show all their working.

More care should be taken in the spelling of chemicals, apparatus and techniques so as to avoid any ambiguity.

Comments on specific questions

Question 1

(a) The apparatus was generally named correctly but 'flask' alone was insufficient.

(b) Some candidates gave the ester rather than the carboxylic acid as the product.

(b) The colour change was well known.

Question 2

(a) The equation was well known.

(b) Most candidates correctly identified the gas but some confused the test for hydrogen, using a lighted splint, with that for oxygen where a glowing splint is used.

(c) Many candidates failed to realise that experiment 2 had finished and showed further increases in the volume of gas evolved.

(d) Most candidates chose suitable apparatus for the experiment but some lost marks because of insufficient care with the drawing, for example, by allowing gas to escape.

(e) The question states that excess zinc is used but many candidates stated that the reaction stopped because all the zinc had dissolved or that the reactants had been used up.

(f) The function of the copper(II) sulfate as a catalyst was well known.

Question 3

(a) The name of the apparatus was well known.

(b) Few candidates realised that it was necessary to heat to constant mass.

(c) (d) The calculations were generally correct. Errors could be carried forward and if used correctly, credit could be obtained.

Question 4

Many candidates did not realise that copper does not react with dilute sulfuric acid and that copper(II) oxide is used.

Question 5

The direction of water flow in a condenser was well known.

Question 6

The electrolysis of copper(II) sulfate using carbon electrodes was well known.

Question 7

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 8

This question was well answered. A more reactive metal displaces a less reactive metal and *Z* is therefore the most reactive.

Question 9

The use of a volumetric flask to make up solutions was not well known but most candidates knew that a pipette was used to transfer the solution to the conical flask.

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. In the calculation errors are carried forward so that candidates are given credit for correct chemistry even if an error has been made in an earlier part. Candidates were penalised once if answers were given to less than three significant figures (except when the third figure was zero).

Question 10

(a) A colourless solution indicates that a transition metal ion is not present in compound **L**. Candidates who stated that **L** or 'it' is not a transition metal were not given the mark.

(b) (c) Observations were generally correct.

(d) Most candidates knew that nitrate ions are confirmed by warming the solution with sodium hydroxide and aluminium producing ammonia gas which turns litmus blue. If nitric acid or a nitrate was used in the test no test marks were scored but the observation mark could still be obtained. The formula of **L** was generally correct.

Question 11

(a) (b) The calculations were generally correct and, as usual, errors could be carried forward. A minority of candidates gave the answer in **(b) (ii)** to one significant figure and lost the mark.

(c) A significant number of candidates confused exothermic and endothermic reactions.

(d) The points were generally plotted accurately and the correct straight line drawn.

(e) Most candidates identified the incorrect result and read the correct result from their graph.

(f) (g) In order to obtain these marks, it was necessary to extend the straight line graph in both directions and read the corresponding temperature rises correctly from the graph.

Few candidates realised that a temperature rise of 90° would take the final temperature to 105° which is above the boiling point of water.

(h) A temperature use of 90° could be achieved by starting at a lower temperature or by using a different liquid with a higher boiling point. Using another liquid alone was insufficient.

CHEMISTRY

Paper 5070/42
Alternative to Practical

Key Messages

When candidates are asked to connect the points on a graph with one or more curves each curve should include all the points relevant to that curve. Every effort should be made to draw as smooth a curve as possible.

In answering calculations candidates should show all of their working. Most questions involve a one stage calculation and are worth one mark. When the number of marks allocated to a calculation is greater than one, 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.

Candidates should always express their answers to a minimum of two significant figures. In calculations based on titrations answers should be given to three significant figures except when the third figure is zero.

General Comments.

The Alternative to Practical Chemistry paper is designed to test the candidate's knowledge and experience of practical chemistry. Skills tested include recognition and use of chemical apparatus, reading measurements from diagrams of chemical apparatus, recall of experimental procedures, handling and interpretation of data, drawing of graphs, analysis of unknown salts and calculations using experimental data.

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 drawing lines through the points as instructed.

More care should be taken in the spelling of chemicals, apparatus and techniques so as to avoid any ambiguity. Clarity is important in the writing of formulae, for example, in 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. It is often difficult, in calculations, to distinguish between the numbers 4 and 7.

Many candidates continue to confuse the test for hydrogen, using a lighted splint, with that for oxygen where a glowing splint is used.

Comments on Specific Questions

Question 1

(a) A measuring cylinder is the only correct answer. A 'cylinder' alone or 'tube' is not awarded a mark.

(b) The majority of candidates were able to read the volume correctly.

(c) (i) The majority of candidates correctly suggested red as the final colour.

(ii) Correct observations included effervescence, fizzing or bubbling but not that a gas evolves, or carbon dioxide evolves. A gas evolving is not considered to be an observation and a gas can only be named if it is accompanied by a test for the gas.

(d) Most candidates gave the correct alcohol, propanol.

(e) Inaccurate spelling of the ester was commonly seen e.g. ethyl proponate and ethyl propanate. Many correct structures of the ester were seen, a common error being the reversal of the two alkyl groups.

Some candidates gave two answers to this question, writing both the structural and displayed formulae. If one is correct but the other wrong, the mark is lost. It is suggested candidates give only one answer.

Question 2

(a) Most candidates gave a correct test for hydrogen, though some used a glowing splint.

(b) A correct equation was generally given, the most common error being $MgCl$ for the formula of magnesium chloride.

(c) A well-answered question. Most candidates read the thermometer diagrams correctly, calculated the difference and deduced that the reaction was exothermic.

Question 3

(a) The result of the limewater test was often omitted.

(b) Only a very few candidates answered this question correctly. The question asks how the candidate can be sure that all the carbonate has been decomposed. In practical terms the only correct answer is to heat it to constant mass.

(c) The calculation was successfully completed by many candidates using the correct number of significant figures.

Questions 4 to 8

Most candidates gave correct responses to all or most of the multiple choice questions.

Question 9

(a) Most candidates were able to perform this subtraction.

(b) Very few candidates suggested that a volumetric flask is used to make up a 250 cm^3 solution. Alternative answers are a graduated or a standard flask. A beaker or measuring cylinder was often suggested but is not acceptable.

(c) Most candidates correctly suggested the use of a pipette in **(i)**, and in **(ii)** gave a correct colour change for the indicator.

(d) Most candidates read the burette diagrams correctly and deduced a correct mean titre. Candidates who give incorrect readings must deduce a mean titre appropriate to their titres.

(e) – (i) Most candidates gave correct answers to the calculations using the correct number of significant figures.

A few candidates found difficulty with the final part of the calculation in which 106, the molar mass of Na_2CO_3, should be subtracted from the answer to **(h)**.

Answers to the nearest whole number were acceptable for the final part of the calculation.

Question 10

(a) Answers suggesting that **Z** or 'it' is a transition element are not acceptable. Answers must state that **Z** contains a transition element or is a compound of a transition metal or element.

(b) (c) Most candidates gave correct answers to both of these parts.

(d) To obtain the observation mark, a white precipitate, candidates must give the correct test reagents although omission of the acid can still score two marks out of three.

Question 11

(a) Candidates must suggest that the mass decreases because the gas escapes from the flask not just that a gas is emitted, evolved or given off.

(b) A cotton wool plug is used to allow the gas to escape, to prevent a build-up of pressure or to prevent the liquid 'spitting' out of the flask. Answers suggesting that it was used to prevent the gas leaving the flask, or the liquid spilling out of the flask, were incorrect.

(c) All the points were plotted correctly by most candidates although some of the curves lacked smoothness. In a few cases the curve(s) did not pass through all the points.

(d) (i) Many candidates gave the actual mass after 45 seconds rather than the loss in mass as requested.

(ii) The greater loss in mass in experiment 1 compared with experiment 2 should be determined from the two graphs after 75 seconds. Several candidates who read their graphs incorrectly could still gain a mark by subtracting the two masses.

(iii) To determine the most effective catalyst candidates must refer to their graphs. The explanation must be based on a comparison of the slope of each graph.

Experiment 1 is faster as the gradient of the graph is steeper than that of experiment 2. Alternatively it can be observed that the graph flattens out sooner. Candidates who tried to explain it by referring to the results of the two experiments were not awarded any marks as there was no reference to their graphs.

(e) Any answer that referred to the reaction being finished gained the mark. Correct answers included: reaction stopped, reached completion or all the hydrogen peroxide was used up or was completely dissociated. Reference to an 'end-point' was not acceptable.

(f) Most candidates gave the correct answer to this question.