CHEMISTRY

Paper 5070/11
Multiple Choice

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

General comments

There was evidence of guessing in **Questions 12**, **23**, **24** and **38**. Candidates found **Questions 13**, **16** and **18** particularly challenging.

Comments on specific questions

Question 1

Candidates selecting option **C** did not understand the accuracy of measurement specified.

Question 2

Option **D** was a common incorrect choice, indicating that candidates did not understand that 1 *is* suitable. The loss of carbon dioxide from the apparatus is necessary for 1 and that 3 *is not* suitable due to the loss of carbon dioxide through the thistle funnel.

Question 3

In selecting option **A**, some candidates did not correctly estimate or calculate that this spot has an R_f of 0.25.

Question 5

Options **B** and **C** were commonly chosen. There was some evidence of guessing, suggesting gaps in the candidates' knowledge of 1.3*(a)* and *(b)* of the syllabus

Question 8

Candidates who chose option **B** did not take the lost electron into account.

Question 9

Selecting option **C** suggests that some candidates thought that ions in copper are responsible for the flow of electricity.

Question 12

Option **C** was selected almost as much as the key. These candidates probably did not take into account the two electrons in the C–C bond.

Question 13

Some candidates gave more emphasis to the number of moles or to the stoichiometry rather than using the number of moles, formula mass and stoichiometry of the oxygen in each compound

Question 16

Option **D** was commonly selected. Some candidates gave more emphasis to the number of moles than to the stoichiometry of the atoms in the compounds.

Question 18

Option **A** was a common incorrect choice. The graph in this option does show a decrease in mass, but candidates did not understand that the line does not start on the *y*-axis and its shape suggests the starting mass of the anode is infinitely high.

Question 23

Some candidates selected options **B** and **C**, indicating that they did not know the solubility of ammonium and sodium salts, 7.2*(b)* in the syllabus.

Question 24

Options **B** and **D** were chosen by some candidates. These candidates did not know the correct method of salt preparation, 7.2*(b)* in the syllabus.

Question 25

Candidates who selected option **D** confused the catalysts in the Haber and Contact processes.

Question 38

There was some evidence of guessing, where candidates could not work out the name and structure of the ester formed from the reagents given.

Question 40

There was some evidence of guessing, where candidates could not work out the monomer and type of polymerisation from the repeat unit given.

CHEMISTRY

Paper 5070/12
Multiple Choice

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

General comments

Candidates found **Questions 1** and **33** to be quite easy, but found **Questions 16**, **17**, and **24** to be particularly challenging.

There was evidence of guessing on a number of questions.

Comments on specific questions

Question 3

Some candidates chose option **C**, showing a misconception that all dyes of one colour have the same R_f.

Question 14

Candidates selecting option **C** used the incorrect formula, MgOH, rather than $Mg(OH)_2$.

Question 15

Options **A** and **C** were frequently chosen, indicating some candidates were guessing and did not know the definition of the relative atomic mass of an element, 3*(e)* in the syllabus.

Question 16

Option **D** was chosen often. These candidates gave more emphasis to the number of moles than to the stoichiometry of the atoms in the compounds.

Question 17

Option **B** was chosen often. These candidates simply calculated $50 \div 80$ rather than calculating and using the relative formula / atomic masses of Fe_2O_3 / (2)Fe.

Question 18

There was some evidence of guessing, with options **A** and **B** being selected. The graph in option **A** does show a decrease in mass, but the line does not start on the *y*-axis. The graph in option **B** incorrectly shows an increase in mass.

Question 19

Candidates choosing option **B** correctly identified the electrode, but did not use 4*(e)* from the syllabus.

Question 24

Option **C** was chosen often. Candidates knew the correct reagents, but not the correct method for separating insoluble salts.

Question 27

Some candidates selected options **A** or **C** and chose an adjacent element rather than applying knowledge of elements forming ions with noble gas electronic configuration.

Question 28

Option **C** was a popular option for those candidates who incorrectly thought that metals contain negative ions.

Question 32

With option **A**, candidates incorrectly thought that carbon monoxide is a greenhouse gas.

Question 34

Those candidates who selected option **C** did not count the number of atoms attached to the end carbon.

Question 38

In option **D**, candidates had the correct ester, but incorrectly thought that the anhydride required two moles of water. Candidates did not take into account the O atom between the two carbon chains.

Question 39

Options **B** and **D** were frequently chosen. These are both synthetic polymers, unlike the option **C**, which was not chosen as often. Perhaps these candidates thought that any synthetic polymer releases oxides of nitrogen when burned.

Question 40

There was some evidence of guessing, with both options **B** and **C** being selected. Candidates could not work out the monomer and type of polymerisation from the repeat unit given.

CHEMISTRY

Paper 5070/21
Theory

Key messages

- Some candidates confused ideas about chemical equilibria and rate of reaction. Some used collision theory when answering questions about chemical equilibria.
- Candidates often struggled when balancing equations because they used incorrect formulae. Candidates must recognise which elements have diatomic molecules and those where it is appropriate to use the atomic symbol in an equation. Candidates found ionic equations more difficult to balance than 'molecular' equations.
- Candidates must use the correct terminology when answering free response type questions, for example when referring to structure and bonding. They must be careful not to contradict a correct answer with an incorrect one, for example stating that an ionic compound has intermolecular forces.

General comments

Candidates appeared to have sufficient time to complete all of the examination paper. Candidates were often able to interpret and explain data given to them in questions.

Candidates often gave the working out for the calculations, which allowed credit to be awarded for error carried forward. Candidates must be careful to quote answers to an appropriate number of decimal places or significant figures. Unless otherwise stated in the question three significant figures are sufficient.

In ***section B*** there was no unpopular questions. A significant proportion of the candidates attempted all four optional questions, which does not follow the rubric for this section.

Comments on specific questions

Section A

Question 1

This question was about different compounds.

(a) Some candidates recognised the test for a nitrate and gave silver nitrate.

(b) Candidates often chose potassium phosphate, since it is a compound that contains two of the essential elements. These candidates did not recognise that potassium phosphate does not contain an ion with a charge of –1.

(c) Many candidates recognised that magnesium carbonate contains an ion with a charge of +2.

(d) Some candidates recognised lithium bromide as a compound that reacts with chlorine to give an orange colour. A significant proportion of the candidates chose aluminium iodide instead. A small proportion of the candidates did not attempt the question.

(e) Many candidates recognised the description for methane.

Question 2

This question was about calcium carbide, carbon dioxide and ethyne.

(a) Many candidates found this question very demanding. The best answers recognised that there were weak intermolecular forces in carbon dioxide and strong electrostatic attractions between the positive and negative ions in calcium carbide. Many candidates were confused and referred to molecules, covalent or intermolecular forces with respect to calcium carbide. Some candidates mentioned both ionic bonding with intermolecular forces in the same sentence about calcium carbide. Candidates were much more likely to appreciate that carbon dioxide was a covalent compound with weak intermolecular forces. A common misconception was to refer to intermolecular forces between bonds or between atoms. Other candidates explained the low boiling point of carbon dioxide in terms of weak covalent bonds. With calcium carbide, candidates were more likely to refer to ionic bonds than electrostatic attraction between ions but often contradicted their answers by referring to giant covalent or strong intermolecular forces.

(b) Many candidates could construct the equation for the reaction between calcium carbide and water. A common misconception was to give the formula for calcium hydroxide as CaOH.

(c) The meaning of the term *hydrocarbon* was well understood by most candidates. The most common misconception was to refer a 'mixture' of only hydrogen and carbon or to forget the significance of the word 'only' in the definition.

(d) Many candidates could predict the formula of the fifth member of the homologous series.

(e) (i) Most candidates referred to addition and some gave either hydrogenation or reduction.

(ii) The most common prediction was C_2H_4, although some candidates gave C_2H_6. A small proportion of candidates did not attempt this question.

(f) Many candidates could draw the displayed formula for the three repeat unts of poly(chloroethene). Only a small proportion of the candidates gave either one or two repeat units. Most drawings included the continuation bonds at the end of the formula. A small proportion of the candidates did not attempt this question.

Question 3

This question was about copper and copper compounds.

(a) Many candidates appreciated it was the presence of mobile electrons that explained the electrical conductivity of copper. Candidates could use delocalised electrons instead of mobile electrons but the reference to free electrons was not considered sufficient to mean mobile electrons.

(b) Many candidates could describe a chemical test for copper. Most of these candidates used either aqueous sodium hydroxide or aqueous ammonia. It was advantageous to use aqueous sodium hydroxide since there did not need to be a reference to excess reagent in the answer. Candidates that used aqueous ammonia were expected to appreciate that the blue precipitate becomes a dark blue solution on addition of excess aqueous ammonia.

(c) (i) Candidates found this question demanding and often gave equations or the names of the products formed rather than an observation. Suitable observations included bubbling, formation of a pink solid and the blue solution becoming colourless.

(ii) Most candidates were able to explain that graphite was inert or would not react with the electrolyte during the electrolysis. References to graphite having a high melting point were not credited.

(d) Some candidates could construct the ionic equation for the reaction. Candidates normally gave the correct state symbols but sometimes had the metal ions as solids rather than as an aqueous solution. Other candidates had equations with all the formulae as ions.

(e) A significant proportion of the candidates did not appreciate they had to calculate the mass of oxygen in the compound and as a result calculated an incorrect empirical formula. The empirical formula of Cu_2O was correctly calculated by a significant proportion of the candidates. A common misconception was using the atomic number rather than the relative atomic mass to calculate the amount in moles of copper and oxygen. Other candidates used the relative formula mass of copper oxide even though they had not been given the formulae to work out the amount in moles. The best answers used a table format to show the working out, which allowed the award of error carried forward where appropriate.

(f) Some candidates gave answers that implied that an alloy was a compound of two metals or a metal and another element; this type of answer was not credited.

Question 4

This question was about the halogens.

(a) Some candidates focused on the diffusion that takes place, others on the evaporation of bromine liquid and some on both processes. Candidates often used these terms in their explanations. The idea that particles were moving was well understood by the candidates and some went further to state that the motion was random. The movement from high concentration to low concentration was mentioned in many answers but this was not always linked to the movement of particles. Better performing candidates were careful not to use the words directly from the stem of the question but explained the process in their own words. It was important that the candidates referred to particles in their answers.

(b) (i) The best answers described the trend in the colour by stating the colour got darker. Other candidates gave the colours of the individual halogens. Candidates could recall the colour of chlorine and bromine but did not know the colour of iodine and often referred to brown rather than dark grey. Some candidates misinterpreted the question and gave the colours of the silver halide precipitates instead.

(ii) The physical state of each halogen was well known. The most common error was to state that iodine was a liquid or a solution.

(iii) The uses of chlorine were well known. Many answers focused on aspects of water treatment and purification.

(c) Most candidates interpreted the diagram to give the molecular formula. Some candidates gave an empirical formula rather than a molecular formula.

(d) The best answers used the correct mole ratio to determine the moles of oxygen as 0.037/4 and then multiplied this by the molar gas volume. Some candidates neglected to quote the answer to two significant figures.

Question 5

This question was about platinum and vanadium.

(a) Candidates often gave two correct properties. The most common answers referred to coloured compounds and more than one oxidation state. A common misconception was that the metals themselves were coloured rather than their compounds.

(b) (i) Many candidates referred to the activation energy being reduced. Some candidates missed this out and referred to an alternative pathway and more successful collisions.

(ii) Some candidates could recall the conditions for the Contact process. Other candidates gave inappropriate conditions, in particular quoting a pressure in excess to that needed. Answers that simply quoted high temperature and low pressure were allowed. A small proportion of candidates did not answer this question.

(c) Many candidates could balance the equation.

(d) (i) Many candidates referred to fractional distillation; some candidates mentioned electrolysis instead. A small proportion of candidates did not answer this question.

(ii) Many candidates appreciated that the reaction showed a gain of electrons so must be a reduction. Other candidates wanted to use the loss of oxygen and/or the gain of hydrogen but this was inappropriate for the example given. A small proportion of candidates referred to the decrease in oxidation state of oxygen, which was accepted.

Section B

Question 6

This question was about alcohols.

(a) (i) Most candidates recognised the general trend in the density of the alcohols.

(ii) Most candidates recognised the general trend in the boiling point of the alcohols but did not explain the trend. Only a very small proportion of the candidates appreciated the importance of intermolecular forces. Of the small proportion of candidates that gave an explanation most referred to more bonds being broken either not identifying the bonds or referring to covalent bonds.

(b) (i) The term strong acid was well known by candidates.

(ii) Candidates found this question quite challenging and were often unable to draw a structure that contained the ester linkage. The correct name, ethyl butanoate, was given by some candidates but it was often reversed and quoted as butyl ethanoate.

(c) The regents and conditions for the oxidation of ethanol were not well known. The most common correct answers were potassium manganate(VII) or potassium dichromate with heat or under reflux. A small proportion of candidates used aerial oxidation.

(d) (i) Candidates found this equation quite difficult to construct. The formula for calcium ethanoate was often incorrect as was the formula for molecular hydrogen. If candidates had the correct formulae they were normally able to balance the equation.

(ii) Candidates often described that the reaction was slower but gave explanations that were not sufficiently detailed in terms of collisions between particles. Candidates rarely mentioned that the particles were less crowded or there were fewer particles per unit volume. In terms of collisions, most candidates did not refer to collision frequency but focused on successful collisions instead and were not credited for this type of comment. A small proportion of the candidates did not attempt this question.

Question 7

This reaction focused on the extraction and chemistry of aluminium. A significant proportion of candidates did not attempt one or more of the questions.

(a) (i) Some candidates mentioned that aluminium is a reactive metal and others related the position of aluminium and carbon in the reactivity series.

(ii) The best answers referred to dissolving aluminium oxide in molten cryolite to increase the electrical conductivity of the electrolyte. Other candidates referred to lowering the melting point of the aluminium oxide. Answers that were not specific but just referred to getting a lower temperature or it was cheaper were not credited.

(iii) Candidates found this equation very challenging. Many answers had equations that did not balance by symbol or by charge. Candidates often put the electrons on the wrong side of the equation. Some candidates gave the reaction of hydroxide ions to give oxygen rather than that of the oxide ion.

(b) (i) Candidates often could not apply their knowledge of reduction to the example given. Answers had to be specific oxygen lost from aluminium oxide, electrons gained by aluminium ions or a decrease in the oxidation state of aluminium. Many candidates mixed these ideas and gave answers such as aluminium oxide gains electrons or the oxidation number of aluminium oxide decreases.

(ii) The best answers calculated the amount in moles of aluminium oxide and then used the mole ratio to calculate the amount of aluminium and finally calculated the mass. Candidates often calculated the incorrect relative formula mass or used 54 as the relative atomic mass of aluminium.

(c) Candidates found this question challenging and rarely mentioned layers of positive ions being able to slide easily.

(d) The idea that bond breaking is endothermic and bond making is exothermic was well known but candidates found it more difficult to apply this information without making contradictory statements in the explanation.

Question 8

This question focused on barium nitrate and some gaseous compounds of nitrogen.

(a) (i) Candidates often found this question challenging because they muddled the two volumes of $25.0\,cm^3$ and $34.0\,cm^3$. As a result, many candidates calculated the incorrect amount in moles in aqueous barium hydroxide and the incorrect concentration of nitric acid. The best answers used three stages; firstly calculating moles of barium hydroxide; secondly the moles of nitric acid and lastly the concentration of nitric acid. Candidates who used this method allowed for any error carried forward marks to be easily applied.

(ii) Candidates often gave extra details about how the aqueous barium nitrate was made, even though this was not needed. The best answers then described heating the aqueous solution until saturation or crystallisation point, filtering and washing the crystals with cold water and finally a suitable way of drying, which was normally between filter paper. A significant proportion of candidates did not mention heating until a saturated solution was made but instead heated to dryness. When describing the filtering stage most candidates neglected to mention washing the crystals and if they did not mention washing, they often did not use an organic solvent or cold water.

(b) Candidates could normally balance the equation once they had the correct formulae for the reactants and products. Many incorrect equations were seen from equations that used formulae such as $BaNO_3$ and Ba_2O.

(c) Many candidates gave an effect of acid rain on buildings typically using words such as corroded, reacted with and eroded.

(d) (i) Candidates found this question very demanding and did not use the structure of hydrazine to help with their answer. A significant proportion of candidates drew two separate NH_2 ‘molecules’ and others drew a double bond between the nitrogen atoms. A small proportion of candidates left this question blank.

(ii) Candidates found this question quite challenging and often seemed to give a rehearsed answer that was appropriate for a liquid. Most candidates compared 0 °C with both the melting and the boiling point, even though there only needed to be a comparison with the melting point.

Question 9

This question was about calcium and its compounds.

(a) Some candidates appreciated that potassium manganate(VII) is used to test for reducing agents and were able to describe the correct colour change. Other candidates used potassium dichromate instead, with the correct colour change of orange to green. It was not necessary to give the presence of acid but many candidates did add this relevant detail. Only a small proportion of the candidates gave the test for an oxidising agent instead.

(b) Many candidates could interpret the symbol for a calcium ion. Candidates were more likely to get the number of neutrons correct than the number of electrons.

(c) (i) The best answers appreciated that the position of equilibrium moves to the right to replace the carbon dioxide that had been lost. Some candidates thought the reaction would not return to an equilibrium because of the hole in the container. Other candidates focused on the rate of reaction and used collision theory to explain the shift of position.

(ii) The best answers appreciated that the position of equilibrium moves to the right because the forward reaction is endothermic. Other candidates focused on the rate of reaction and collision theory to explain the shift of position.

(d) The candidates used the information to appreciate that oxygen was the gaseous product of the reaction and this helped many to write a balanced equation. The most common misconceptions were to use monatomic chlorine and/or monatomic oxygen.

(e) Many candidates used the rules for solubility of salts to suggest that calcium nitrate is soluble. The knowledge that calcium sulfate is insoluble was not well known and some candidates gave this as their answer. A small proportion of candidates left this question blank.

CHEMISTRY

Paper 5070/22
Theory

Key messages

- Many candidates need more practice in reading the stem of a question carefully.
- Candidates were not proficient in explaining the physical properties of compounds and elements in terms of structure and bonding.
- Better performing candidates understand specific chemical terms given in the syllabus and are able to define these.
- Some candidates need more practice in writing formulae and constructing equations, especially ionic equations.

General comments

Many candidates tackled this paper well and performed well in both ***Section A*** and ***Section B***. Most candidates gave answers of the appropriate length to questions involving free response and responded to most parts of each question. Notable exceptions were **Questions 2(e)(ii)** (determining molecular formula), **3(c)(ii)** (describing the hydrolysis of carbohydrates) and **9(b)(i)** (test for oxidising agents), where a significant minority of candidates did not respond.

A significant proportion of candidates did not appear to read the stem of the question carefully enough. For example, in **Question 2(c)(ii)** many wrote the formulae of the ions rather than giving the direction of movement, in **Question 2(d)** most candidates did not refer to electrons despite the request in the stem of the question and in **Question 3(b)(iii)** many just gave a definition of a catalyst instead of describing how a catalyst increases reaction rate. In **Question 5(a)**, some candidates gave an answer relating to alkenes despite the question stating one **other** reason to carry out cracking (other than making alkenes). In **Question 9(b)(ii)**, many did not use the formula of lead(IV) oxide, which was given. Candidates also need practice in understanding the meaning of some key words and command words appearing in questions. For example, in **Question 2(c)(ii)** the word 'observations' was not understood; many candidates gave the name of a substance formed rather than what you can see. In **Question 6(e)(ii)** the command word 'explain' was ignored by any candidates and in **Question 6(b)(ii)** the command word 'state' was ignored by some.

Some candidates gave concise, well-reasoned answers to questions involving free response. Others need to practice writing their answers with greater precision. For example, in **Question 3(a)** some candidates wrote their answers in no apparent order and did not mention particles. In **Question 6(b)(ii)**, although many mentioned collisions between particles few candidates wrote about collision frequency. In the same question, some candidates did not make it clear whether they were writing about magnesium powder or magnesium ribbon. Some candidates need more practice answering questions about redox reactions. For example, in **Question 7(c)(i)** a lack of precision in the answers led to candidates not gaining credit.

Many candidates need more practice in defining and understanding specific chemical terms in the syllabus. For example, many omitted essential words in their definition of electrolysis in **Question 3(c)(i)** and others did not appear to understand the meaning of the term hydrolysis in **Question 3(c)(iii)** or molecular formula in **Question 5(b)(ii)**. Many candidates need more practice at identifying salts and understanding that they do not include oxides and hydroxides (**Questions 4(a)** and **9(d)**).

Some candidates' knowledge of organic chemistry was good. Other candidates need practice in distinguishing molecular formulae from other types of formulae, especially when related to organic compounds as in **Question 5(b)(ii)**. Most candidates need practice in drawing a section of an addition polymer chain that has side groups (**Question 5(c)**) and in deducing the formula of metal salts of carboxylic acid (**Question 6(b)(i)**). Some need practice in drawing the structures of esters (**Question 6(c)**).

The writing of balanced equations was not always successful. **Question 6(b)(i)** caused particular problems in terms of both identifying the species involved and balancing the equation. Ionic half equations, such as in **Question 3(b)(ii)**, is an area for improvement for many candidates.

Some candidates' knowledge of structure and bonding was good. Many others need more practice in relating physical properties to structure and bonding. In **Question 2(a)**, many candidates could not distinguish between molecular structures and ionic structures and ionic and covalent bonding. Many candidates realised that sodium chloride is ionic but then contradicted themselves by referring to weak intermolecular bonds between the particles. Others referred to the particles in sodium chloride as being atoms. Many candidates need more practice in explaining metallic bonding especially the electrostatic force of attraction between the positive ions and electrons.

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. Others should make sure that they set out each stage of their working clearly in calculations involving three or four steps such as **Question 4(d)**. Statements in the form of 'moles of X =' or 'mass of Y =' help to make clear the processes involved.

Comments on specific questions

Section A

Question 1

This was the best answered question on the paper.

(a) Many candidates identified ammonia as an alkaline gas. The commonest errors were to suggest hydrogen chloride or sodium chloride. The latter answer shows that some candidates did not realise that sodium chloride is a solid at room temperature.

(b) Some candidates realised that copper(II) sulfate is used to test for water. The commonest incorrect answers were calcium carbonate or sodium chloride. Hydrogen chloride or chlorofluorocarbons were also frequently seen.

(c) The majority of candidates correctly identified aluminium sulfate. The commonest incorrect answer was ammonia, presumably because the oxidation number of nitrogen is +3.

(d) A minority of candidates identified calcium carbonate as a solid used in flue gas desulfurisaton. A wide range of incorrect answers were seen, the commonest being chlorofluorocarbons. A few suggested hydrogen chloride, sodium chloride or carbon dioxide.

(e) Many candidates gave the correct answer (potassium nitrate). Ammonia was also accepted as an answer. The commonest incorrect answer was chlorofluorocarbons. A few candidates suggested carbon dioxide.

Question 2

Many candidates wrote the electronic configuration of a chlorine atom correctly in **(b)** and stated the correct direction of movement of the ions in **(c)(ii)**. A majority identified the OH^- and Cl^- ions in **(c)(iv)** and calculated the empirical formula of the compound correctly in **(e)(i)**. Many candidates needed more practice explaining in terms of structure and bonding why molecular compounds have low boiling points and ionic compounds have high boiling points in **(a)**. Others needed practice in defining specific terms such as electrolysis (**(c)(i)**) and in understanding the difference between observations and names of substances (**(c)(iii)**). In **(d)**, very few candidates read the question properly and gave answers related to the reactivity series rather than in terms of transfer of electrons.

(a) Many candidates only used the information in the diagram and referred to chlorine particles being far apart so forces are weak and sodium chloride particles are close together, so the forces are strong. A significant number of candidates suggested, incorrectly, that the covalent bond in chlorine is weak. Many candidates realised that sodium chloride is ionic but then contradicted themselves by referring to weak intermolecular bonds between the particles. Others referred to the particles in sodium chloride as being atoms.

(b) A majority of the candidates were able write the correct electronic configuration of a chlorine atom. The commonest error was to suggest 2.8.8. A few candidates omitted the outer shell electrons completely.

(c) (i) A significant number of candidates need more practise in learning and memorising definitions. Many candidates did not mention that electricity or an electric current is involved in electrolysis. Others suggested that 'electrolysis is the separation of ions' rather than the breakdown of a compound.

(ii) Many candidates realised that the positive ions go to the cathode and the negative ions go to the anode. A considerable minority did not read the question properly and gave the names or symbols of the ions e.g. positive ions: Na^+ negative ions: Cl^-. Others gave both symbols and the direction. A minority wrote confusing statements such as 'chloride ions go to the cathode'.

(iii) Many candidates did not gain credit because they wrote about the substance formed e.g. 'chlorine' rather than the observations e.g. 'green gas seen'. Those candidates who gained credit generally wrote about 'bubbles' or 'fizzing'.

(iv) Many candidates identified the OH^- and Cl^- ions. The commonest errors were to write only one of the ions, to leave out the negative charge on one of the ions or to write the formulae of a sodium ion and a chloride ion.

(d) Very few candidates performed well on this question. Most simply referred to the reactivity of the elements instead of referring to the ions. Few referred to the transfer of electrons, as requested in the stem of the question. Most of those who referred to electrons wrote about ease of loss of electrons rather than gain of electrons.

(e) (i) A majority of the candidates calculated the empirical formula correctly. The commonest errors were to either use 71 as the relative atomic mass of chlorine or 2 as the relative atomic mass of hydrogen. A significant minority of the candidates divided the mass by the atomic number rather than the relative atomic mass. A small number of candidates tried to use the 36.3 g sample incorrectly. Others obtained the answers by first calculating the per cent mass of each element, which was unnecessary.

(ii) Some of the candidates who gave the correct empirical formal in **e(i)** were able to calculate the molecular formula correctly. Others did not understand the importance of using the relative molecular mass of the compound and either guessed the answer, gave the same answer as the empirical formula or did not respond to the question. The commonest errors were to suggest $C_4H_2Cl_2$ or $C_6H_2Cl_2$.

Question 3

Some candidates gave good answers to **(a)**, **(b)(i)** and **(b)(iii)** of this question but others needed more practice in writing ionic equations in **(b)(ii)** and in revising aspects of carbohydrate chemistry including hydrolysis in **(c)(i)** and **(c)(ii)**.

(a) Many candidates recognised that diffusion was occurring and there was (bulk) movement of the ink from areas of high concentration to areas of low concentration. Fewer explained diffusion in terms of the particles moving randomly. Some candidates just described the ink moving. A minority of the candidates did not recognise the physical process of diffusion and described a chemical reaction between the ink and the water. The best answers included the word diffusion and the idea of particles moving randomly from higher to lower concentrations. A few candidates suggested that the bulk movement of particles was from low to high concentrations.

(b) (i) Many candidates gave the correct test using sodium hydroxide or aqueous ammonia; fewer gave the correct result. The commonest errors being ‘red-brown precipitate’ (confusion with iron(III) ions), or the omission of the word ‘precipitate’. Other common errors included the use of silver nitrate as the test reagent and ‘white precipitate’ as the result of the test.

(ii) A minority of the candidates constructed the correct ionic equation. Electrons were often missing or on the wrong side of the equation. Oxygen atoms or molecules or oxide ions were often included by those who were unaware that an ionic equation included half-equations. A significant number of candidates wrote the equation as $3Fe^{2+} \rightarrow 2Fe^{3+}$ with the charges balanced but the number of ions unbalanced.

(iii) The best answers referred to a decrease in activation energy. Many candidates did not gain credit because they gave a definition of a catalyst rather than stating how a catalyst increases the rate of reaction. Candidates should be encouraged to read the stem of the question carefully to ascertain what is being asked. A few candidates suggested that the activation energy was increased.

(c) (i) Few candidates gave an example of a carbohydrate polymer. The commonest correct answers were ‘starch’ or ‘glycogen’. Incorrect answers included monosaccharides such as glucose or sucrose or disaccharides such as maltose. Synthetic polymers such as nylon or terylene were not uncommonly seen as incorrect answers. A significant number of candidates did not respond to this question.

(ii) The best answers included ‘heating with hydrochloric acid’ or ‘using an enzyme such as amylase at room temperature’. Many candidates did not understand the question and wrote about the meaning of hydrolysis rather than how hydrolysis is carried out. Many candidates thought that water on its own would carry out the hydrolysis. Heating was rarely mentioned. The best answers included the term reflux. Unspecified enzymes were often mentioned, A significant number of candidates suggested using enzymes at high temperatures. Others suggested carrying out the reaction with acids at room temperature. A significant number of candidates did not respond to this question.

Question 4

This was one of the best answered questions on the paper. Parts **(b)**, **(c)(ii)**, **(d)** and **(e)** were generally well answered. In **(a)**, many candidates did not identify the syllabus example of oxygen and did not appear to know the term salt or take note of the term pollutant in the stem of the question. In **(c)(i)**, many did not write with sufficient precision about the electronic configuration of the Group I elements.

(a) Many candidates did not read the stem of the question properly and did not exclude salts or pollutants as requested. Incorrect answers included specific salts such as sodium chloride or pollutants such as bacteria or sewage. The incorrect answers such as ‘sand’ or ‘clay’ were often seen. Others suggested gases such as hydrogen or helium.

(b) Many candidates constructed the correct equation. The commonest errors were to write H or 2H instead of H_2 as a product or to omit one of the balancing 2s. A few wrote the formula of lithium hydroxide as $Li(OH)_2$ rather than LiOH.

(c) (i) Many candidates did not write with sufficient precision about the electronic configuration of the Group I elements. Common examples of this included ‘all have the sae number of electrons in the outer shell’, ‘all lose the same number of electrons’ or ‘they are all in the same Group’.

(ii) Many candidates described the trend in reactivity of the Group I elements correctly. The commonest errors were to omit the direction of the trend e.g. ‘reactivity decreases’ instead of ‘reactivity increases down the group’. Others mentioned the elements but did not complete the analysis sufficiently e.g. ‘potassium is more reactive than lithium and sodium’.

(d) The calculation was generally well done. The best responses showed all their working clearly arranged and gave an answer to three significant figures. Common errors included forgetting to divide the moles of oxygen by 2, dividing 16 by 68 to get the number of moles of hydrogen peroxide or forgetting to give the answer to 3 significant figures. Candidates should be advised not to round up their figures until the final stage of the calculation since this may lead to significant errors.

(e) (i) Candidates gave the correct answers 'electrolysis' or 'cracking' to an equal extent. The commonest errors were to suggest 'hydrogenation' or 'hydrolysis'. The word 'process' in the question occasionally led to the answers 'Haber process' or 'Contact process', even though neither of these processes produce hydrogen.

(ii) Most candidates could describe the advantages of a fuel cell compared with a petrol engine. Some responses lacked precision. For example, 'environmentally friendly', 'saves energy' or 'cheap' were too vague. Candidates who stated that 'water is formed' omitted the essential word 'only'. This word is essential because water is also formed when petrol is combusted.

Question 5

Most candidates gave good answers to **(a)(ii)** (balancing an equation), **(b)(i)** (general formula) and **(b)(iii)** (products of incomplete combustion). In **(b)(ii)**, many candidates did not appear to know the meaning of a molecular formula and in **(c)** only a minority of candidates were able to construct the formula for the polymer.

(a) (i) Some candidates gave another suitable reason why cracking is carried out. A significant number ignored the important phrases 'alkenes are made by cracking' and 'give one **other** reason' in the stem of the question. Candidates who stated, 'to make alkenes' could not be credited because alkenes have already been referred to in the question. The commonest correct answers were 'to make hydrogen' or 'to make smaller alkanes from larger alkanes'. A significant number of candidates confused the process of cracking with the process of fractional distillation.

(ii) Most candidates were able to balance the equation. A few candidates made errors in balancing the hydrogen atoms.

(b) (i) Most candidates were able to write the correct general formula for an alkene. The commonest error was to suggest C_nH_{2n+2}.

(ii) Many candidates did not appear to know the term 'addition reaction' and wrote formulae bearing no relationship to the reactants. The nearly correct formula C_3H_7OH was only rarely seen. Many answers appeared to be guessed.

(iii) Many candidates chose carbon monoxide and water as the correct products of incomplete combustion. A significant minority chose 'carbon dioxide' despite it being in the stem of the question. A common error was to suggest 'hydrogen'.

(c) Few candidates were able to draw the correct structure of poly(propene). Those who did generally drew three repeat units. The commonest error was to draw the partial structure of poly(ethene). Other incorrect diagrams frequently contained double bonds, divalent hydrogen atoms, CH_2 side groups or a combination of these. A significant number of candidates drew the structure of a simple alkane. Very few candidates who drew the correct carbon skeleton omitted the extension bonds at either end of the chain.

Section B

Question 6

Most candidates gave good answers to **(a)**, **(d)(i)** and **(e)(i)**. In **(b)(i)** many candidates made basic errors in deducing the formula of magnesium methanoate or in balancing the equation. In **(b)(ii)**, few candidates stated both decreased surface area for the ribbon and decreased collision frequency. In **(d)(ii)**, few candidates identified the reaction as oxidation and in **(e)(ii)** most candidates did not heed the command word 'explain' in the question.

(a) Many candidates gave a good explanation of the term weak acid. The commonest error was to refer to concentration rather than extent of ionisation. Candidates should be advised to try to write with greater precision, as many suggested that it was the ions which ionised rather than the molecules.

(b) (i) Many candidates gave an incorrect formula for magnesium methanoate was incorrect; HCOOMg or $(HCOOH)_2Mg$ being the commonest errors. Of the candidates who did write the correct formula, many made other errors such as omitting H_2 as a product, giving H_2O as a product or not balancing with 2HCOOH.

(ii) For some candidates it was not clear whether they were writing about the magnesium powder or the magnesium ribbon. Others did not take sufficient notice of both command words 'state' and 'explain' and did not write whether the reaction was faster or slower with the magnesium ribbon. Those candidates who referred to collisions often referred to 'less collision' rather than 'lower frequency of collisions'. Many confused collision frequency with the effectiveness of the collisions.

(c) Those candidates who named the ester correctly generally drew its structure clearly, showing all of the atoms and all of the bonds. The commonest error was to suggest the name methyl propanoate. Those who did not name an ester often omitted to draw the structure. Common errors in the structure included the structures of ethyl ethanoate or propyl ethanoate. A significant minority drew the structure of a carboxylic acid, an aldehyde or a ketone rather than an ester.

(d) (i) Many candidates named ethanol as the reactant, which is converted to ethanoic acid when vinegar is made. The commonest error was to suggest the general term 'alcohol'. A significant number of candidates did not respond to this question.

(ii) A minority of the candidates identified the reaction as an oxidation. A wide variety of incorrect answers were seen; 'addition' or 'exothermic' being the commonest incorrect responses. A significant number of candidates did not respond to this question.

(e) (i) Most candidates predicted a suitable value for the density of ethanoic acid.

(ii) Most candidates did not heed the command word 'explain' in the question and simply rewrote the question as 'when the number of carbon atoms increases the boiling point increases'. A few referred to the difference in mass of the molecules or differences in chain length. Others disadvantaged themselves by referring to breaking bonds in the carbon chain rather than referring to the increased forces of attraction between the molecules as the chains get longer.

Question 7

This question answered well by some candidates, especially **(a)** and **(c)(ii)**. Others made basic errors in explaining the exothermicity of the reaction in **(b)** in terms of bond breaking and bond making. In **(d)**, most candidates did not realise that two reactions are involved in the removal of impurities in the blast furnace. In **(e)**, a majority of the candidates did not give a convincing explanation of metallic bonding.

(a) Many recognised that hematite is the common ore of iron. The commonest error was to suggest bauxite. A few candidates did not understand the question and either wrote the formula of iron(III) oxide or gave the name 'iron oxide' rather than the name of the ore.

(b) The best answers were given by candidates who wrote two separate statements such as 'bond forming is exothermic and bond breaking is endothermic' then 'ore energy is released than absorbed'. Candidates who tried to write down the explanation in a wordier way often ended up contradicting themselves. For example, 'bond forming is exothermic and bond breaking is endothermic so the energy absorbed in bond breaking is less than the energy <u>absorbed</u> in bond making'. Some suggested that 'because bond formation is exothermic, the reaction must be exothermic' without reference to bond breaking. Others muddled the nature of the enthalpy change in bond making and breaking by suggesting that 'bond forming is endothermic and bond breaking is exothermic'.

(c) (i) Some candidates wrote good simple answers such as 'the iron oxide loses oxygen'. Others did not give answers with sufficient precision e.g. 'the iron loses oxygen', which was not accepted because iron appears on both sides of the equation. Candidates who tried to answer the question in terms of electron gain often gave muddled answers or did not write precisely enough. For example, some candidates suggested that iron or iron oxide gains electrons (rather than iron ions gain electrons). Others suggested electron loss from the iron ions.

(ii) Many candidates calculated the mass of iron correctly, setting out their working clearly. Others showed minimal working and did not indicate whether the quantities referred to moles or grams. A significant number of candidates did not calculate the relative molecular mass of iron(III) oxide correctly.

(d) The best responses referred to the decomposition of limestone to calcium oxide and then the reaction of calcium oxide with silicon dioxide to form slag. Many candidates did gain credit because they suggested that calcium carbonate reacts directly with silicon dioxide. Some of these candidates went onto correctly suggest that the slag can be separated from the iron because slag is less dense than iron.

(e) The majority of candidates did not give a convincing explanation of metallic bonding. Many simply stated that metallic bonding is the bonding between two metals. Many wrote about positive ions, but fewer mentioned a sea of electrons/delocalised electrons. Fewer wrote about strong electrostatic force of attraction or that the force of attraction was between the positive ions and electrons.

Question 8

This was the best answered of the ***Section B*** questions. Most candidates performed well in **(a)(i)**, **(b)**, **(c)** and **(d)**. Few candidates were able to give sufficient details for the preparation of crystals of sodium sulfate in **(a)(ii)**.

(a) (i) The majority of candidates carried out the calculation correctly. The commonest errors were either to muddle the volumes of acid and alkali (using $25\,cm^3$ of alkali and $24\,cm^3$ of acid) or to use the same volume (usually $25\,cm^3$) for both acid and alkali. Others did not use the stoichiometry of the equation in the second step or misapplied it by multiplying the moles of alkali by 2.

(ii) Many candidates did not write with sufficient precision. The best responses suggested heating the solution to the crystallisation point or heating until a saturated solution is formed and then allowing crystallisation. Most candidates wrote vague statements such as ‘heat to form the crystals’ or ‘evaporate the solution to get the crystals’. Few candidates suggested washing the crystals with cold water or organic solvent. Many candidates gained credit for ‘drying with filter paper’. A significant number of candidates suggested heating in an oven, which would dehydrate the crystals unless a low temperature had been specified.

(b) Many candidates balanced the equation successfully. The commonest errors involved the balancing of hydrogen atoms, $4H_2SO_4$ or $4H_2O$ being frequently seen.

(c) Most candidates were able to draw the correct dot-and-cross diagram for sulfur dichloride. The commonest errors were to draw two pairs of electrons in each overlap area between the S and C*l*, to omit the non-bonding chlorine electrons or to omit one or both pairs of non-bonding electrons on the sulfur atom.

(d) Many candidates recognised that sulfur dichloride is a liquid at room temperature. Fewer gave a full reason, often omitting reference to the boiling point or melting point. Others did not make it clear that the room temperature or quoted room temperature is between the melting point and boiling point and just mentioned the values of the melting and boiling points.

Question 9

Part **(a)** was well answered by a majority of the candidates. In **(b)(i)**, many candidates gave a test for reducing agents rather than oxidising agents. In **(b)(ii)**, many candidates did not use the information in the question and wrote the incorrect formula for lead(IV) oxide. In **(c)**, many candidates deduced the correct effect of concentration and temperature on the position of equilibrium, but few gave convincing explanations. In **(d)**, many candidates did not appear to understand the meaning of the term salt.

(a) Many candidates deduced the number of electrons and neutrons correctly**.** The commonest errors were to suggest 82 electrons through not taking into account the ionic charge or to add the mass number to the atomic number to obtain the number of neutrons. A significant number of candidates inverted the number of electrons and neutrons giving 125 electrons and 80 (or 82) neutrons.

(b) (i) A majority of the candidates gave the test for reducing agents involving potassium manganate(VII) rather than the iodide test for oxidising agents. Others gave qualitative tests for specific ions. For example 'sodium hydroxide turns colourless'. Those candidates who suggested adding potassium iodide usually gained credit for the correct colour change. A significant number of candidates did not respond to this question.

(ii) Some candidates did not use the information in the question and wrote the incorrect formula for lead(IV) oxide, Pb_2O_4, PbO or even Pb without oxygen being frequently seen. Another common error was not to balance the hydrogen atoms correctly, H_2O or $4H_2O$ being frequently seen.

(c) (i) Most candidates recognised that the position of equilibrium would shift to the left when the concentration of chlorine is increased. Few gave a convincing explanation in terms of the equilibrium shifting to reduce the concentration of added chlorine. Many wrote vague statements such as 'the reaction goes to the left to form more lead(IV) chloride. A number of candidates wrote vague answers relating to the reaction going from high to low concentration of chlorine.

(ii) Most candidates recognised that the position of equilibrium would shift to the left when the temperature is increased. Few gave a convincing explanation in terms of the forward reaction being exothermic or the backward reaction endothermic. Many candidates did not make it clear whether the forward or backward reaction was endothermic.

(d) Some candidates realised that all nitrates are soluble in water. Others did not appear to understand the meaning of the term salt and suggested lead oxide, lead carbonate or lead hydroxide. Other common errors included lead chloride and lead sulfate.

CHEMISTRY

Paper 5070/31
Practical Test

Key messages

- Success in this paper required a candidate to meet the practical and mathematical demands of a volumetric exercise.
- The examination's qualitative tasks generally involved test-tube observations. Candidates competent in following instructions involving test-tube reactions and in the accurate recording of their observations, performed well.

General comments

Candidates capably carried out the titration involved in **Question 1** and many successfully used the data generated in answering the related calculations.

While all the candidates attempted the tests in **Question 2**, there was variation in the standard and completeness of the observations recorded.

Comments on specific questions

Question 1

(a) The results table was almost always completed properly. The majority of candidates produced concordant titres; there was some variation in their accuracy. Once two concordant titres are obtained, there is no benefit from performing additional titrations.

Most candidates attempted all the calculations that followed and many performed well.

(b) Most candidates were able to use their results from **(a)** to correctly calculate the number of moles of KOH. Providing their answer to three significant figures was problematic for a number of candidates.

(c) The majority correctly divided the answer in **(b)** by 3 but a few multiplied by 3.

(d) (i) Many followed the guidance using their answer from **(c)** to calculate the concentration of **Q**.

(ii) This was often correctly tackled either by multiplying **(c)** by 20 or alternatively dividing **(d)(i)** by 2.

(e) Correctly performing both steps of the calculation caused problems for a number of candidates. Some candidates were able to calculate the *M*r of hydrated citric acid.

Question 2

Candidates should be encouraged to make full use of the Qualitative Analysis Notes supplied.

(a)(i)

Test 1
Some of the observations provided suggested that not all candidates were familiar with the use of universal indicator solution. A colour indicating **R** is weakly acidic was required.

Test 2
While many recorded a colour showing a strongly alkaline solution as a result of adding excess sodium hydroxide, some added insufficient alkali.

Test 3
Relatively few noted that there was no change on addition of the alkali; many correctly tested and identified the ammonia produced on warming the mixture.

Test 4
Most noted the white precipitate produced on addition of the silver nitrate.

(ii) Identifying the hydrogen ion was least frequently seen. Observations in **Test 1** of precipitates led some candidates to suggest iron(III) ions.

(iii) Those who recorded the alkaline gas ammonia in **Test 3** generally identified the ammonium ion. Ammonia ion was not creditworthy.

(iv) The identification of the anion as chloride based on a white precipitate in **Test 4** was made by most candidates but there were a few who incorrectly offered sulfate.

(b) (i)

Test 1
Some candidates only noted the added solid disappearing and missed the bubbling. Others noted the bubbles but did not attempt to identify the gas.

Test 2
The addition of aqueous sodium hydroxide to the solution needed to be done gradually with mixing. In this case, there was excess acid to remove before any precipitation took place. Those who were careful in their addition of alkali reported a blue precipitate, which was insoluble in excess.

Test 3
The same comments made for **Test 2** apply here. There were some candidates who reported that the blue precipitate did not dissolve in excess ammonia and others who did not record the presence of a deep blue solution, asserting instead that the precipitate had become a deeper blue.

Test 4
The majority correctly recorded no change as a result of adding the reagents.

(ii) In general, those who observed the blue precipitates formed in **Tests 2** and **3** identified copper(II) as being present in **S** and those who showed the gas in **Test 1** was carbon dioxide, identified carbonate in **S**.

CHEMISTRY

Paper 5070/32
Practical Test

Key messages

- Success in this paper required a candidate to meet the practical and mathematical demands of a volumetric exercise.
- The examination's qualitative tasks generally involved test-tube observations. Candidates competent in following instructions involving test-tube reactions and in the accurate recording of their observations, performed well.

General comments

Candidates capably carried out the titration involved in **Question 1** and many successfully used the data generated in answering the related calculations.

While all the candidates attempted the tests in **Question 2**, there was variation in the standard and completeness of the observations recorded.

Comments on specific questions

Question 1

(a) The results table was almost always completed properly. The majority of candidates produced concordant titres; there was some variation in their accuracy. Once two concordant titres are obtained, there is no benefit to be gained from performing additional titrations.

Most candidates attempted all the calculations that followed and many performed well.

(b) Providing the answer to three significant figures was problematic for a number of candidates.

(c) The majority correctly divided the answer in **(b)** by 3 but a few multiplied by 3.

(d) Many followed the guidance using their average volume from (**a**) and answer from **(c)** to calculate the concentration of **Q**. A few ignored their answer to **(c)** and calculated the concentration of **Q** from scratch i.e. by using all the volumetric data and the mole ratio for the reaction.

(e) Correctly performing both steps of the calculation caused problems for a number of candidates. Incorrectly scaling the volume to 200 cm^3 was the most common error.

Question 2

Candidates should be encouraged to make full use of the Qualitative Analysis Notes supplied.

(a) (i)

Test 1
Some of the observations provided suggested that not all candidates were familiar with the use of universal indicator solution. A colour indicating **R** is weakly acidic was required.

Test 2
While many recorded a colour showing a strongly alkaline solution as a result of adding excess sodium hydroxide, some added insufficient alkali.

Test 3
Relatively few noted that there was no change on addition of the alkali. Many correctly tested and identified the ammonia produced on warming the mixture.

Test 4
Most noted the white precipitate produced on addition of the barium nitrate.

(ii) Identifying the hydrogen ion was least frequently seen. Observations in **Test 1** of precipitates led some candidates to suggest iron(III) ions.

(iii) Those who recorded the alkaline gas ammonia in **Test 3** generally identified the ammonium ion. Ammonia ion was not creditworthy.

(iv) The identification of the anion as sulfate based on a white precipitate in **Test 4** was made by most candidates but there were a few who offered chloride.

(b) (i)

Test 1
Some candidates only noted the added solid disappearing and missed the bubbling. Others noted the bubbles but did not attempt to identify the gas.

Test 2
The addition of aqueous sodium hydroxide to the solution needed to be done gradually with mixing. In this case, there was excess acid to remove before any precipitation took place. Those who were careful in their addition of alkali reported a white precipitate, which dissolved in excess. A good proportion of these also noted that the final solution was colourless. There were a significant number who either missed the solid or did not get it to dissolve.

Test 3
The same comments made for **Test 2** apply here. There were more candidates who reported that the precipitate did not dissolve in excess ammonia.

Test 4
The majority correctly recorded no change as a result of adding the reagents.

(ii) In general, those who found that the white precipitate formed in **Tests 2** and **3** dissolved in excess identified zinc as being present in **S** and those who showed the gas in **Test 1** was carbon dioxide, identified carbonate in **S**.

CHEMISTRY

Paper 5070/41
Alternative to Practical

Key messages

- Candidates frequently found it difficult to express ideas about accuracy and reliability of experiments. In particular they did not seem to be able to understand aspects of practical procedure in relation to increased accuracy.
- Candidates find it difficult to describe a plan for an experiment. Candidates who performed less well had little idea of how to approach the question. Some responses tended to focus on the theory behind the task rather than describing procedures, for example, stating that a substance reacts with an acid and naming the products rather than saying that the substance needs to be added to an acid, stirred and filtered.

General comments

In general, candidates showed a good understanding of many practical aspects. Some found it more difficult when the wording or context of a question was not familiar to them and found applying principles to new contexts more difficult.

Comments on specific questions

Question 1

(a) Most candidates recognised this as chromatography.

(b) Most candidates recognised that the solvent level was too high; some stated the answer in reverse.

(c) Many candidates identified all of the correct answers; some answers were incomplete.

(d) (i) Most candidates measured these correctly within tolerance.

(ii) Most candidates could calculate this. A significant number did the division the wrong way round, ending up with an answer of 4 rather than 0.25.

Question 2

(a) Most candidates correctly identified carbon dioxide.

(b) (i) Candidates found this question difficult. The most common mistake was to simply repeat the question in different words stating that the heat must be kept the same. Many others suggested totally different methods such as water baths, when the question specifically referred to control of the Bunsen burner.

(ii) A number of candidates clearly did not understand the idea of control of variables in an experiment. A significant number repeated the variable of heat from **(i)** when the question asked for other variables.

(c) Most candidates were able to answer this correctly, but some gave the carbonate with the shortest time rather than the slowest.

(d) This question was not well answered. There appeared to be a general lack of understanding of reliability in practical terms. A significant number of candidates left this question blank.

Question 3

(a) (i) Most candidates were able to recognise a pipette.

(ii) A significant number of candidates seemed to be confused by the question and named any another piece of equipment used in a titration. A burette was the most common incorrect answer. Some candidates did not pick up on the instruction that the piece of equipment was part of measuring the $25.0\,cm^3$ of **L**.

(iii) There was a general lack of understanding of accuracy. Despite this, many candidates recognised that a pipette is more accurate than a measuring cylinder. A common incorrect answer was to say that a pipette only measures $25\,cm^3$. Other candidates did not make their answer comparative and simply said 'it is accurate' rather than 'more accurate'.

(b) Many candidates recognised the volumetric flask.

(c) Many candidates did not seem to have any appreciation of the washing procedures needed in a titration to ensure accuracy of the results. The most common incorrect answer was distilled water.

(d) Few candidates knew these colour changes. Some reversed correct colours.

(e) (i) Most candidates could complete the table correctly. A large number of candidates did not show the appropriate level of precision in the figures; 0 was often recorded instead of 0.0.

(ii) Many candidates did not comment that the first two results were identical. Those who had made errors in the table and did not have identical results were unable to express ideas about concordancy.

(f)–**(j)** Generally, candidates could either complete most parts correctly or had little idea about any of the calculation. Some candidates struggled with the fact that two answers could be the same numerical value.

(k)(i)(ii) Few candidates had any idea about the significance of these washing procedures. There was confusion about what **L** was and others thought **L** was in the burette. In **(i)** candidates often wrote about concentration in the conical flask rather than about number of moles.

Question 4

Candidates found this difficult.

The most common errors were of omission with candidates not stating practical procedures. In other cases, candidates did not make it clear what substances they were referring to, for example what it was they were filtering. Some candidates wrote about crystallisation of the filtrate rather than purification of the residue. Weaker responses included inappropriate procedures such as distillation.

Question 5

(a)–**(c)** Most candidates answered this question well. Many candidates did not notice that there were three marks available for **(c)** and did not identify both the ion and the gas.

Question 6

(a) (i) Candidates frequently did not recognise that both the starting and finishing temperatures and masses were required.

(ii) Many candidates answered this correctly. Some did not make a comparison so it was not clear whether they thought the metal, or the glass was the better conductor.

(iii) Many candidates recognised that there was heat loss but were unable to come up with a second reason.

(iv) This was generally well answered. Some candidates did not realise that they needed to write about changes to the apparatus.

(b) Many candidates calculated this correctly. Others simply omitted this part.

(c) (i) Most candidates recognised the temperature rose related to the exothermic nature of the reaction.

(ii) The graphs were generally well drawn.

(d) Many candidates completed this correctly. Some made an estimate without extending the line. Others came up with numbers that did not seem to have any relation to the graph.

(e) (i) Few candidates recognised that this would give a final temperature of 110°C and that water would boil at 100°C.

(ii) Candidates who had not recognised the problem found it very difficult to suggest a sensible alternative procedure. Others did not give enough detail for example, suggesting using a different liquid than water but not mentioning that it must have a boiling point above 110°C.

CHEMISTRY

Paper 5070/42
Alternative to Practical

Key messages

- Candidates should familiarise themselves with the experimental procedure in experimental determinations of energy changes, such as that referred to in **Question 6**. This includes familiarity with sources of error and their correction.
- When plotting graphs, points should be plotted using small crosses or small dots **without** using a circle around the points. Examiners need to inspect all the points to decide if they are plotted correctly. Therefore, the points must be clearly visible.

Comments on specific questions

Question 1

(a) This question was answered reasonably well. Copper was occasionally described as either black or blue and sometimes named as copper(II). The observation for oxygen was occasionally given as colourless gas without mentioning bubbles.

(b) This was answered well. The most common error was the use of a glowing splint to test for hydrogen.

Question 2

(a) This was answered correctly by almost all of the candidates.

(b) The question asks candidates how to use a Bunsen burner in order to keep the amount of heat supplied constant. Candidates often mentioned experimental procedure that used apparatus other than a Bunsen burner, such as a water bath or electrical heater. Putting a thermometer into a solid that is being heated was a common incorrect answer. The high temperatures achieved by a Bunsen burner would cause a thermometer to break. Keeping the distance between the flame and the test-tube constant was the most common correct answer.

(c) Candidates found this somewhat difficult. Some mentioned controlling the temperature despite the requirement of the question to focus on the metal nitrate. The metal nitrate is a solid and thus references to concentration and volume were inappropriate.

(d) (i) The majority of candidates took the average of all three results for all the nitrates. The instruction 'Do **not** use any anomalous times' was largely ignored and candidates performed poorly on this question. Potassium nitrate was the most likely nitrate to be correct. Unfortunately, this was often the only correct answer

(ii) Most candidates stated correctly that lithium nitrate decomposed the fastest. The instruction 'Use information from the table to explain your answer' was often ignored. This meant that comments on the reactivity of lithium were commonly used as an explanation rather than reference to the lowest average time representing the fastest rate of decomposition. The correct answer was that the (average) time for the decomposition of lithium nitrate was the *smallest*. Statements such as 'the average time was faster' or 'the average time was low' (without comparison) were occasionally seen.

Question 3

(a) This was answered correctly by almost all of the candidates.

(b) Many candidates were able to name the graduated flask.

(c) If the burette is washed out with water immediately before filling it, the solution in the burette will be diluted i.e. its concentration will decrease. This means that the titre will increase. Some candidates may have had the right idea but found problems expressing themselves adequately.

(d) Some candidates knew the correct colour change occurring in a titration involving methyl orange; others had the colour change the wrong way round.

(e) Reading burette diagrams was a strength of the candidates. The initial burette reading in titration 1 was often recorded as 0 instead of 0.0. Burettes are accurate pieces of measuring apparatus and this accuracy should be evidenced by recording readings to 0.1 cm^3.

The burettes were occasionally read 'upside down' i.e. values of 24.3, 11.2, 35.1, 21.8 and 45.5 were seen. Another error seen very occasionally, was to use the top of the meniscus rather than the bottom. This led to readings that were 0.1 cm^3 out.

(f) This was answered very well.

(g) This was answered well.

(h) This was answered well.

(i) This was the part of the calculation that candidates had most problem with.

25.0 cm^3 of **K** was transferred into apparatus **A**. The solution was then made up to 500 cm^3 of solution **L** using distilled water. This means that **K** and **L** both contained the same number of moles of NaOH. Thus candidates' answers to **(h)** and **(i)** should have been the same. Many candidates divided the answer to **(h)** by 20.

(j) Many candidates ignored the instruction to give their answer to **three** significant figures. This applied particularly if the second or third significant figure was a zero.

(k) If the conical flask had been washed out with **L** (NaOH) instead of water there would be a small amount of NaOH remaining in the flask after washing. This means that the acid in the burette would need to react with the 25.0 cm^3 of **L** transferred into the conical flask by pipette plus the small amount of NaOH remaining in the flask from the washing. This means that the titration volume would be larger. Many answers said that there would be no change.

Question 4

There were some excellent answers to this question. The following omissions were common.

- The mixture of solids and the acid should have been stirred with a glass rod or heated. This was to increase the rate of the reaction as well as to encourage the process of dissolving.
- There should have been an indication of when to stop adding the acid to the mixture. It was necessary for all the copper(II) carbonate to react so that carbon was the only solid residue on the filter paper. Thus excess acid was necessary. When bubbling stopped this indicated that all the copper(II) carbonate had reacted.
- Purification of the carbon should have involved washing the residue on the filter paper and drying between filter papers.

Some candidates gave unnecessary details of how they would treat the filtrate.

Question 5

(a) Answers should have mentioned that **R** contains ions of a transition element or a compound containing a transition element as evidenced by the coloured solution. The words ions or compound were often absent.

(b) (i) This was answered well by most of the candidates. 'White precipitate' was seen occasionally

(ii) This was answered well.

(c) (i) This was answered well.

(ii) This was answered less well than the previous parts. Many candidates stated that the precipitate was insoluble in excess aqueous sodium hydroxide.

(iii) Most candidates identified ammonia gas or ammonium ions; very few identified both. Nitrate ion was a common wrong answer. Even though ammonia is evolved in the tests for both ammonium ions and nitrate ions, candidates should know the different reagents used for each test.

(d) This was answered well by most of the candidates. Silver nitrate was seen occasionally. If formulae are used to identify reagents such formulae must be correct.

Question 6

(a) (i) Heat loss was a common correct answer. Candidates should be aware that this is a common source of error in this type of experiment.

(ii) Despite being asked for 'changes that can be made to the apparatus' many candidates made other suggestions involving magnesium or hydrochloric acid. Very few candidates gave two correct answers.

(b) This was answered extremely well. There were very occasional instances of the thermometer being misread.

(c) This was answered well. It was necessary to state that each of the experiments gave a rise in temperature as opposed to the temperature rises all increased as the mass of magnesium increased.

(d) Candidates performed well on this question. The most common error was drawing two straight lines that did not go through all the points but were deliberately drawn to intersect at 0.50 g of magnesium.

(e) (i) This was answered very well.

(ii) It was common to see answers in the region of 4 °C by candidates who determined the temperature rise as opposed to the highest temperature, thus not adding 20 °C to the reading from the graph.

(iii) This was often left blank, presumably because candidates were looking to read the graph at 26 °C instead at 6 °C.

(iv) Candidates did not often realise that they were required to read off the mass of magnesium where the lines intersected.

(f) (i) This was answered reasonably well.

(ii) This was answered fairly well. Candidates were expected to use the mole ratio of 1:2 to find the number of moles of hydrochloric acid and to multiply by ten to find the concentration. Some candidates carried out one of these two procedures; both were seen only rarely.