CHEMISTRY

Paper 5070/11
Multiple Choice

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

General comments

Candidates found **Questions 1**, **2**, **14**, **29**, and **39** less demanding.

Candidates found Questions **5**, **14**, **19**, **24**, **31** and **39** challenging. There was evidence of guessing in **Questions 2**, **7**, **14** and **39**.

Comments on specific questions

The following shows where some candidates have gaps in their knowledge, skills and/or understanding.

Question 1

Options **A** and **D** were popular incorrect choices. Most candidates knew that **B** was incorrect, but many could not link the stated volumes to the most appropriate of the remaining three pieces of apparatus. (1.1 a)

Question 2

Option **C** tended to be chosen by candidates that performed well overall. If **C** had 'could' rather than 'must' then it would be correct. In ruling out the key, **A**, perhaps candidates did not think that immiscible mixtures can be separated by distillation.

Question 5

Many candidates chose option **A**. They correctly identified R as chlorine, but then did not use the solubility rules (7.2 b) to eliminate magnesium sulfate.

Question 7

Clear evidence of guessing was found here, showing that some candidates did not have the mathematical skills to use percentages / ratios to deduce the answer.

Question 13

Options **B** and **D** were commonly chosen. There was evidence of guessing here, showing that some candidates did not have the mathematical skills and/or knowledge of stoichiometry (3 i) to deduce the answer.

Question 14

Options **A** and **C** were commonly chosen. There was evidence of guessing here, showing that some candidates did not have the mathematical skills and/or knowledge of stoichiometry (3 i and h) to deduce the answer.

Question 19

Many candidates chose option **A**. They either did not know the correct oxidation state of the silver ion and/or they may have thought that the number of electrons had to be the same in both columns.

Question 24

Many candidates chose option **A**. These candidates did not identify sand as silicon dioxide (2.3 b) and ignored the unchanged charges on the ions.

Question 25

Options **A** and **B** were common incorrect choices. Candidates did not identify the link between iodine gaining electrons, meaning that thiosulfate must have lost electrons. (6.2 c)

Question 29

Option **D** was chosen more often than the key by candidates who performed well overall.

Question 31

Many candidates chose option **B**. These candidates did not know the trend in melting points in Group 1 (8.2 a).

Question 38

Some candidates selected option **D**. Candidates linked the 'C_3H_7' part of the formula to *prop*anoic acid / *prop*anoate and ignored the carbon in 'COO'.

Question 39

There was evidence of guessing here by all candidates and shows poor application of 11.5 f. It is possible that the use of text rather than formulae in the item added to the demand.

Question 40

There was clear evidence of guessing here, showing that some candidates cannot apply 11.5 f.

CHEMISTRY

Paper 5070/12
Multiple Choice

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

General comments

Candidates found **Questions 4** and **9** less demanding'

Candidates found **Questions 18**, **24 and 25** particularly challenging.

There was evidence of guessing **Questions 10**, **11**, **13**, **15**, **17**, **18** and **30**.

Comments on specific questions

The following shows where some candidates have gaps in their knowledge, skills and/or understanding.

Question 1

Candidates did not correctly link the given volume to be measured with the most appropriate piece of apparatus. (1.1 a)

Question 8

Some candidates chose option **B**. These candidates selected the number of neutrons rather than the nucleon number.

Question 10

There was some evidence of guessing by candidates. Candidates may benefit from drawing the molecules when answering this type of question.

Question 11

There was evidence of guessing by candidates. Candidates found it difficult to process the written description of bonding in a molecule to then deduce the answer.

Question 13

Options **B** and **D** were popular incorrect choices. There was some evidence of guessing here, showing that candidates did not have the mathematical skills and/or knowledge of stoichiometry (3 i) to calculate the answer.

Question 14

Option **A** was chosen almost as much as the key. Candidates may have chosen option **A** because it was the only organic compound and/or the compound with the greatest number of (different) atoms and so most likely to be the key.

Question 15

Options **C** and **D** were popular incorrect choices. There was some evidence of guessing here, showing that candidates did not have the mathematical skills and/or knowledge of 3 j to calculate the answer.

Question 16

Some candidates selected option **B** and did not have knowledge / ability to apply 4 f.

Question 17

There was some evidence of guessing by candidates. These candidates may have had difficulty with two linked statements in a table.

Question 18

Option **C** was a popular incorrect choice. Option **C** will give the largest voltage, but the question specifies this is being done ‘in a school laboratory’ and ‘in a safe way’, so the use of sodium rules this out.

Question 24

Option **A** was a popular incorrect choice. These candidates did not identify sand as silicon dioxide (2.3 b) and ignored the unchanged charges on the ions.

Question 25

More candidates chose option **D** than the key. 6.2 c states that candidates should be able to identify redox reactions in terms of electron transfer and 7.2 b / 8.3 a, cover the nature of bonding in iron(III) chloride. Candidates did not link these together. It is also possible that they ignored the emboldened ‘not’ in option **D**.

Question 27

Option **D** was a popular incorrect choice. Candidates selected the pH value with a 7 (7.8) and did not consider the difference between the pH of substance P (6.6) and neutral pH.

Question 30

Options **C** and **D** were popular incorrect choices. There was some evidence of guessing here, showing that candidates did not have a sound knowledge of 7.2 a / b.

Question 31

Some candidates chose option **D**. The only difference to the key was the pressure of 200 atm rather than 1–2 atm. Candidates who could not recall the correct conditions (7.4 a) may have chosen option **D** by mistakenly thinking that a higher pressure is used in preference to a lower pressure in an industrial process.

Question 38

Some candidates chose option **D**. Candidates linked the 'C_3H_7' part of the formula to *prop*anoic acid / *prop*anoate and ignored the carbon in 'COO'.

CHEMISTRY

Paper 5070/21
Theory

Key messages

- Candidates are advised to read the question again once they have completed their response to ensure they have answered all of what is being asked. This will help ensure that numerical answers are given to an appropriate number of significant figures and that written responses cover all aspects of the question.
- Candidates need more practice constructing balanced equations, particularly ionic equations.
- Many candidates did not understand the structure of alloys, equilibrium and the drawing of structures of organic compounds.

General comments

Candidates were generally well prepared for this examination and had sufficient time to complete the paper, as only some of the more demanding questions were omitted by some candidates.

Many gave detailed explanations for questions, whilst others stated answers rather than explaining them.

Some candidates confused equilibrium with rate of reaction, success of collisions with collision frequency and the catalysts used for particular reactions. Generation of equations and the products of electrolysis were not well known.

The answers for ***Section A*** questions were generally of a higher standard than those for ***Section B***.

Question 7 was the least popular ***Section B*** question.

Comments on specific questions

Section A

Question 1 – Periodic Table

(a) The catalyst was quite well known. Fe was a common response.

(b) The metal oxide in cryolite was quite well known. Fe was a common response.

(c) The majority of candidates named a metal less reactive than copper. Zinc and copper were common incorrect responses.

(d) The majority of candidates knew the gas. Chlorine and nitrogen were common incorrect responses.

(e) Most candidates named an ion with a –1 charge. Sodium and oxygen were common incorrect responses.

Question 2 – Carbon compounds

(a) (i) Many candidates knew the dot-and-cross diagram for CO_2. Some gave the electronic structure of the atoms or ions. Single bonds and three electrons between the C and the O were also common.

(ii) The separation and motion in a gas were quite well known. Common incorrect responses included comparing to a solid or a liquid or having the particles in clusters or closely packed. Some candidates misinterpreted the question and described a method of separation including boiling and distilling.

(b) (i) The products of photosynthesis were quite well known. Starch, carbohydrates and water were common incorrect responses.

(ii) The meaning of the term enzyme was quite well known. Many candidates described the action of an enzyme.

(c) (i) Many candidates gave a product of combustion. Hydrogen, carbon dioxide and sulfur dioxide were common incorrect responses.

(ii) Uses of kerosene were well known. Burning and fuel were common non-creditworthy responses.

Question 3 – Organic Chemistry

(a) The formula for the alkenes was very well known. C_2H_{2n}, C_nH_{2n+2} and C_nH_{2n+1} were common incorrect responses.

(b) (i) Most candidates named the alkene. Common incorrect responses included propene, buthene, propane and ethane.

(ii) Many candidates gave two correct explanations. ‘Carbon does not have enough hydrogens’, ‘can add more hydrogen’, ‘carbon has not made all of the bonds it can’, ‘carbon and hydrogen molecules’ and omitting the ‘only’ were common incorrect responses.

(c) Better performing candidates defined cracking. ‘Separating into fractions’ or ‘compounds’, ‘breaking bonds’ and ‘forming atoms or elements’ were common incorrect responses.

(d) The effect of CO proved challenging. ‘Lung disease’, ‘lung cancer’, ‘respiratory problems’ and ‘breathing problems’ were common incorrect responses.

(e) (i) Most candidates calculated the empirical formula correctly. Using 35.5 as the A_r of bromine, using B as the symbol for bromine and having an empirical formula of C_2H_3Br or CH_2Br were common.

(ii) The molecular formula proved challenging. Many candidates knew this was twice the empirical formula but gave $C_4H_8Br_2$.

Question 4 – Ammonia and ammonium salts

(a) (i) The catalyst was quite well known. ‘Nickel’, ‘vanadium’, ‘V_20_5’ and ‘ammonium’ were common incorrect responses.

(ii) The action of a catalyst was generally well known but many only described the reaction going via an alternative route. ‘Increasing kinetic energy’ and it ‘giving energy to meet the activation energy’ were other common incorrect responses.

(b) Many candidates calculated the percentage correctly. Some did not give the answer to three significant figures so 28 and 28.18 were common or rounded incorrectly to 28.1. 144 and 9.4 were also common.

(c) (i) Candidate found this challenging with $KMnO_4$, NaOH, KOH, Na_2CO_3 and ammonium common incorrect responses.

(ii) Better performing candidates appreciated how the acidity was decreased. ‘It’s a base’, ‘it lowers pH’ and ‘it reacts’ were common non-creditworthy responses.

(d) Candidates found this challenging. Many gave an endothermic energy profile diagram, did not label the diagram, mixed reactants and products, had no arrow or a double headed arrow for ΔH or labelled the arrow AE.

(e) Candidates found constructing the equation very difficult. N, 2N, H_2O_2 and NH_4 were common.

Question 5 – Metals and metal compounds

(a) Candidates found this difficult, with the majority reducing iron instead of iron ions. Some reversed oxidation and reduction.

(b) Candidates found this very difficult. Many discussed 'free electrons', 'delocalised electrons' or 'electrons carrying charge' without mentioning the mobility of the electrons. Some thought the conductivity was due to ions.

(c) Better performing candidates gave a correct explanation. 'They do not react', 'they do react', 'electrolysis is needed', 'it is a metal' and 'it has a high melting point or boiling point' were common incorrect responses.

(d) The test was quite well known. 'Acidified NaOH' and 'copper sulfate' were common incorrect reagents. 'Precipitate' was frequently omitted from the observations and the colours for Fe^{2+} and Fe^{3+} were often reversed.

(e) (i) Candidates found this very difficult with most ascribing the conduction to the movement of electrons. **'**Free ions', 'delocalised ions' and it is an 'ionic compound' were also common non-creditworthy responses.

(ii) Many candidates gave the correct products. The products were frequently reversed or the ions given for the products**.**

(f) Candidates found matching the property to the use very difficult. 'Low density', 'malleability', 'ductility', 'non-conductor', 'insulator' and 'it does not rust' were common incorrect responses.

Section B

Question 6 – Compounds of Nitrogen

(a) (i) Candidates found this very difficult with many moving the equilibrium to the left. Of those who moved the equilibrium right, few appreciated that the pressure change only affects gaseous compounds hence many described fewer molecules rather than fewer gaseous molecules.

(ii) The majority of candidates described the reaction as endothermic. Common incorrect responses included 'endothermic', 'increases' and 'decreases'. Many explained that heat was given out rather than considering the increase of concentration of NO_2 with increased temperature.

(b) (i) Candidates found generating an equation difficult. PbO_2, H_2 and Pb_2O were common.

(ii) Many candidates gave an effect of acid rain. Damage plants, destroys plants, eutrophication, corrodes skin and skin diseases were common incorrect responses.

(c) (i) The definition of strong was well known. **'**Dissolves completely', 'turns universal indicator red' and 'undiluted' were common incorrect responses.

(ii) Most candidates knew the pH of a strong acid. 4, 5 , 6 and 12 were incorrect responses seen.

(iii) Many candidates gave the correct ion. O^{2-}, OH^{2-} and O^- were common incorrect responses.

Question 7 – Alcohols and Polymers

This was the least popular of the ***Section B*** questions.

(a) Better performing candidates gave the molecular formula. Many gave either a partial or a full structural formula.

(b) (i) Isomerism was quite well known. Many defined an isotope or described elements as isomers.

(ii) The structure of the isomer was quite well known. Many candidates drew a straight chain isomer with a bend in it, repeated the isomer in the question or had Hs missing from their structure.

(iii) Candidates found this difficult. 'Methyl butanoate', 'ethyl butanoate' and 'butanoic acid' were common incorrect responses. Structures often contained a five valent carbon atom, had –O–H– or were guesses.

(c) Candidates found this very difficult. Lots drew a polymer, drew monomers with continuation bonds, had COOH in the structure or $(CH_2)_6C=O$.

(d) (i) The uses of *Terylene* were quite well known. Plastics and packaging were common incorrect responses.

(ii) Candidates found this very difficult. 'Starch', 'protein' and 'nitrogen' were common incorrect responses with 'nylon' being the most common.

(e) Candidates found this very difficult, with most only giving 'breakdown' as their response. Common incorrect responses included 'add water', 'take out water', 'add hydrogen' and 'take out hydrogen'.

Question 8 – Metal and metal compounds

(a) Candidates found this very difficult. Few had layers of positive ions, many had atoms, nuclei or protons. Few had different sized ions in their structure, often describing a pure metal. Many thought that the bonding between different metals stopped the metal being malleable.

(b) Most candidates derived the correct order. A small number reversed the order.

(c) Many candidates derived the numbers of electrons and proton correctly. Common errors included for electrons: 80,199 and 119; and for neutrons: 78, 80 and 199.

(d) Candidates found this very difficult. Common incorrect responses included 'water', 'diluted water', 'hydrate', 'hydrated water', 'distilled water', 'hydrous' and 'water of hydration'.

(e) (i) Candidates found generating the equation very difficult. Some gave the full molecular equation. Common incorrect responses included K_2I, KI_2, Br^{2-}, Br_2^-, I_2^-, Br^+, I^+ and KI_2^+.

(ii) Candidates found this challenging. Many candidates discussed bromide and iodide, compared the reactivity to KBr or K or discussed the reactivity of the group.

Question 9 – Zinc

(a) (i) Better performing candidates calculated the concentration correctly. Many divided by 73 or did not use the stoichiometry.

(ii) Candidates found this challenging. Few discussed surface area and many had the collisions as being less successful rather than less frequent. Some discussed a change in kinetic energy or thought that large pieces have a large surface area.

(b) Candidates found generating this equation difficult. Common incorrect responses included $H^+ + e^- \rightarrow H$ and $2H^+ + 2e^- \rightarrow 2H_2$.

(c) (i) Conditions required for rusting were quite well known. Just 'water' or just 'air' or 'oxygen' were common.

(ii) Candidates found this difficult. Many discussed zinc creating a barrier to water or oxygen or had zinc rusting. Some thought iron is more reactive than zinc,

(iii) Candidates found this difficult with many opting for painting or cars.

CHEMISTRY

Paper 5070/22
Theory

Key messages

- Candidates often had problems when constructing balanced equations (molecular, ionic equations and ionic half-equations) The most common problem was writing the incorrect formulae. Ammonia was often confused with the ammonium ion and some candidates did not appreciate the diatomic nature of hydrogen and chlorine.

- Many candidates showed their working out in calculations, but these were often poorly organised and showed several approaches to a problem. It is particularly important in quantitative questions that the working out is clear so that error carried forward marks can be awarded.

- Candidates must use the correct terminology when answering questions on structure and bonding. It is important to distinguish between particles (atoms, ions and molecules) and attractive forces (metallic bonds, ionic bonds, covalent bond and intermolecular forces). It is also important to give an indication of the strength of the attractive forces e.g. 'strong attraction between particles and strong ionic bonds'.

General comments

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

In ***Section B***, **Questions 6, 8 and 9** were the popular questions and only a small proportion of the candidates answered **Question 7**. Some candidates answered all four questions, in which case the three best marks for the questions were selected.

Comments on specific questions

Section A

Question 1

Most candidates followed the rubric and only gave one answer. Candidates that gave two answers one of which was incorrect, were not given a mark for the item.

(a) Many candidates recognised Fe as the catalyst in the Haber process. Common incorrect answers were Cr and Pt.

(b) Most candidates appreciated that A*l* was used to make food containers. A common incorrect answer was Zn.

(c) Some candidates were not able to recognise Ar and a common incorrect answer was C.

(d) Many candidates recognised that Fe is extracted from haematite. A common incorrect answer was Cr.

(e) Many candidates recognised the O^{2-} ion but a common misconception was to choose a metal such as Mg, Ca or Zn.

Question 2

This question was about halogens and halogen compounds.

(a) (i) Many candidates could draw the dot-and-cross diagram for a chlorine molecule and only an extremely small fraction of the candidates drew an ionic structure. The most common misconception was to draw a structure with a chlorine-chlorine double bond or to only draw one atom of chlorine rather than two atoms.

(ii) The most common uses given for chlorine involved water purification and/or water treatment. Candidates often included killing bacteria in their answer. Candidates should be advised to refer to bacteria rather than germs and also to refer to killing bacteria rather than just removing them. Candidates often included for making chemicals e.g. acids or plastics but to be awarded a mark the specific name of a compound had to be given.

(b) (i) Since the concentration of the aqueous bromine was not given, a wide range of colours were accepted.

(ii) Many candidates compared the reactivity of bromine with potassium rather than with chlorine. Other candidates compared the reactivity of bromine with chloride and this was not credited. The best answers stated that bromine was less reactive than chlorine. A small but significant proportion of the candidates did not answer this item.

(c) The candidates found this question quite challenging since a common misconception was that there are spaces between the particles. Often candidates wrote a contradiction stating that they were far apart but closely packed. Candidates also described the movement of the particles even though the scaffolding only mentioned arrangement and separation. A significant proportion of the candidates did not understand the term separation and described a separation technique such as distillation.

(d) Candidates often appreciated that the ozone layer protects the Earth from the Sun's rays but they did not always state the correct type of electromagnetic radiation. Some candidates mentioned infrared rather than ultraviolet. A common misconception was that these rays were reflected by the ozone layer rather than absorbed. Skin cancer was the most common problem given with eye cataracts being the next most common. A significant proportion of the candidates linked the ozone layer with global warming.

Question 3

This question was about alkanes. A significant proportion of the candidates did not answer one or more of the items concerned with cracking.

(a) The general formula for the homologous series of alkanes was well known.

(b) (i) The name butane was well known.

(ii) Most candidates drew structures that had all the atoms and all the bonds. However, a significant proportion of the candidates missed out one or two hydrogen atoms. A common misconception was to draw butane again but as a 'bent' chain.

(c) (i) Many candidates identified boiling point as the correct property; a significant proportion of candidates included melting point as well. Melting point was considered a contradiction.

(ii) Most candidates were unable to recall a use for naphtha. Typically, candidates gave uses such as jet fuel, road surfaces, lubricating oils or just as a fuel. Candidates rarely mentioned the idea of a chemical feedstock used in the petrochemical industry to make chemicals. Some candidates had the misconception that feedstock was related to feeding animals in agriculture.

(d) (i) Some candidates were able to express the idea that the smaller alkanes were more in demand or more useful. Other candidates mentioned that petrol or alkenes were made by cracking.

(ii) Candidates were often able to give two conditions needed for cracking. Typically, candidates gave high temperature or heat and either high pressure or the use of a catalyst.

(e) The correct empirical formula was given by many candidates, with the best answers showing their working out within a table. The most common misconceptions involved using the molar masses of Cl_2 and/or H_2 rather than that molar mass of the atoms. Only a very small proportion of the candidates inverted the relationship between amount in moles, molar mass and mass. Some candidates used atomic numbers rather than the relative atomic masses of the elements concerned. Other candidates calculated the simplest ratio of the actual percentages.

Question 4

This question was about ammonium sulfate.

(a) Many candidates explained why farmers put fertilisers on their fields. The most common answers focused on improving crop yield, getting faster crop growth, bigger crops or providing the essential elements or minerals needed by plants. Vague answers such as fertilisers help crops to grow were not given credit. A small proportion of the candidates confused fertilisers with pesticides.

(b) The best answers described the formation of ammonia which escaped from the soil as a gas. Many candidates just referred to the two chemicals reacting together but did not describe the consequence of this reaction. A small proportion of the candidates appreciated that there would be some nitrogen loss but did not mention the production of ammonia. Some candidates thought the chemicals would poison the plants.

(c) Many candidates were not able to calculate the correct molar mass for ammonium sulfate and as a result did not calculate the correct percentage by mass. Other candidates did not appreciate they had to use both the nitrogen atoms in ammonium sulfate. Some candidates used the atomic numbers to work out the molar mass for ammonium sulfate. The best answers showed all their working out and quoted the answer to the required three significant figures. Candidates that did not show their working out often missed out on possible error carried forward marks following an incorrect molar mass calculation.

(d) Candidates found balancing this equation very challenging. The formula for sodium sulfate was not well known and the nitrogen containing product was often written as NH_4 or NH_4OH rather than NH_3 for ammonia.

(e) Some candidates were able to draw a correct energy profile diagram but others either got the relative heights of the reactant and product energy incorrect or had the positions of the reactants and products reversed. Candidates should be advised that they should draw the enthalpy change with a line with an arrowhead pointing in the correct direction. The use of double headed arrows needs to be qualified by an indication of the sign of the enthalpy change.

Question 5

This question was about metals and metal compounds.

(a) Almost all the candidates followed the instructions in the question and described oxidation and reduction in terms of electrons. No credit was given for answers that used changes in oxidation number. Candidates were much more likely to explain that zinc was oxidised because it lost electrons rather than hydrogen ions were reduced because they gained electrons. A common misconception was that hydrogen rather than the hydrogen ion was reduced.

(b) Candidates were often able to describe the observations when aqueous ammonia was added to aqueous zinc ions. The most common mistake was to write that the white precipitate did not dissolve in excess ammonia or referred to the formation of a white solution.

(c) (i) Candidates often gave the correct two products but sometimes had them being produced at the wrong electrode. A common misconception was to name the ions that moved to the anode and the cathode rather than the name of the product formed. Other candidates wrote electrode reactions and these were given credit if they produced the correct products, Cl_2 and Zn. Only a small proportion of the candidates gave the products of the electrolysis of aqueous zinc chloride instead of molten zinc chloride.

(ii) Covalent, atoms, molecules, intermolecular forces were all given as answers to the question. Answers using any of these ideas were not credited. The best answers appreciated that zinc chloride had a giant ionic lattice with strong attractions between the positive and negative ions.

(d) (i) The best answers compared the reactivities of carbon and aluminium and appreciated that aluminium is more reactive than carbon. A typical misconception was to refer to the presence of the oxide layer on the surface of aluminium. A small but significant proportion of the candidates did not attempt this item.

(ii) Many candidates referred to aluminium being light or light weight but this was not given credit. Candidates had to refer to aluminium having a low density. Other candidates appreciated that aluminium does not corrode and this was also given credit.

(iii) Candidates often just referred to cheaper in their answer without offering any idea why. The best answers referred to the metal ores being finite, or land pollution was reduced either because there was less mining or less waste to be disposed of in landfill sites.

Section B

Question 6

This question was about nitrogen and oxides of nitrogen

(a) Many candidates recalled that nitrogen was 78% by volume of dry air.

(b) (i) Many candidates predicted that the position of equilibrium would move or referred to the rate of reaction. A common misconception was that the position of equilibrium would increase or decrease. Those candidates that predicted that the position of equilibrium does not move rarely supported their prediction by reference to the moles of gaseous product being identical to the moles of gaseous reactant. The most common answers did not refer to gases in their answers.

(ii) Many candidates were able to describe the relationship between temperature and the concentration of NO but could not use this relationship to explain that the enthalpy change of reaction was endothermic. The best answers appreciated that as the temperature increases the equilibrium moves to the right hand side to absorb energy so the reaction was endothermic. A common misconception was that the enthalpy change increased or decreased.

(c) Candidates found balancing the equation quite challenging often because they gave incorrect formulae. Typically, ammonia was the most likely formula to be incorrect often written as NH_4. Candidates also neglected to give the correct formula for hydrogen gas, giving H rather than H_2. Candidates rarely used fractions to balance the equation.

(d) (i) The source of nitrogen oxides in the atmosphere was well known with the most common answers being car exhausts, lightning and volcanoes. Vague answers such as factory smoke or industry were not given any credit.

(ii) Corrosion and erosion were given credit even if it was buildings being corroded and metals eroded.

(iii) The formula H^+ was quite well known, although some candidates wrote the equation for neutralisation.

Question 7

This question about carboxylic acids and polymers was the least popular of the four questions in ***Section B***. A significant proportion of the candidates did not answer at least one of the items in this question.

(a) Candidates that wrote a molecular formula were often correct. However, many candidates drew structural formula or a mix of structural and molecular formulae.

(b) (i) Candidates were more likely to get the name of the ester correct than the structure. Common errors with the name were methyl propenoate or methyl proponoate. Almost all the candidates that attempted to draw the ester drew all the atoms and all the bonds. A common error was to draw a correct ester linkage but have an additional –OH group bonded to the methyl group.

(ii) Better performing candidates gave the uses stated in the syllabus: solvents, perfumes or flavouring

(c) Candidates found this question challenging and rarely mentioned acidified potassium manganate(VII). Candidates were often not able to name potassium manganate(VII) and often included the incorrect oxidation state for example potassium(VII) manganate and potassium manganate(V). Other candidates did not include the oxidation state or used an incorrect name such as potassium magnate. Some candidates gave acidified potassium dichromate which was given full credit. The most common reactions described were based on the conditions used for hydrating ethene.

(d) (i) Candidates found this question very challenging. The most common errors were to draw an incorrect linkage often with extra oxygen atoms or neglecting to include the continuation bonds. A small proportion of the candidates gave contradictory structures for the amide link.

(ii) The most common misconception was to describe the physical change called condensation. The idea of monomers reacting to form a polymer and a small molecule such as water was poorly expressed.

(e) The answer amino acid was often known by candidates.

Question 8

This question was about metals and metal compounds

(a) The best answers used a fully labelled diagram with close packed positive ions surrounded by a sea of electrons and then indicated that there was a strong attraction between the positive ions and the delocalised electrons. Candidates often appreciated that there was a strong attraction between particles but did not specify the particles. Some candidates drew diagrams which showed electrons only on the outside of the closely packed positive ions and not embedded within the arrangement of the positive ions. Lots of answers referred to positive and negative ions, atoms or molecules and described the force of attraction as covalent bonds, ionic bonds or intermolecular forces. Some candidates did not attempt this item.

(b) Many candidates were able to use the data in the table to deduce the correct order of reactivity.

(c) Candidates sometimes quoted the number of neutrons as the number of electrons and vice versa. A common misconception was that the electrons lost to make the positive ions were taken from the number of neutrons.

(d) Candidates found this question very challenging. To be awarded the state symbol mark all the formula had to be correct and many candidates gave Ag^{2+} or Zn^{+}. Some candidates did not attempt this question.

(e) (i) The term anhydrous was not well known by candidates. Candidates often used terms like dehydrated to answer the question.

(ii) Candidates often appreciated they had to reverse the reaction but did not describe how this was achieved. Some mentioned that they would cool the nickel(II) chloride but often forgot to state that they would add water as well.

Question 9

This question was about metals and metal compounds.

(a) (i) Many of the answers were poorly constructed and did not clearly show the working out. This often made it difficult to award error carried forward marks for later working out following an initial mistake. The best answers calculated the moles of carbon dioxide using the molar gas volume, then used the stoichiometric relationship in the equation to calculate the moles of HCl. Finally, the concentration of HCl was worked out. Many candidates used the incorrect volumes in their calculation using the volume of acid and the molar gas value.

(ii) Candidates often appreciated that the particles moved faster or the particles gained kinetic energy. They then describes that there was more effective or more successful collisions. References to collision frequency were ignored in this question. Some candidates referred to an increased number of particles having equal to or more then the activation energy.

(iii) Candidates often found this question more demanding than **(ii)**. Some candidates did not mention that the particles were more crowded or there were more particles per unit volume. Other candidates incorrectly thought that the particles would move faster. This was considered a contradiction. Some candidates only referred to more collisions rather than using collision frequency in their answers.

(b) Many candidates recalled the definition for an alloy although a common misconception was to refer to the metals combined, bonded together or that an alloy was a compound.

(c) The ionic equation was often correct, but some equations had the electrons as products or were not balanced having more copper particles on the right-hand side of the equation e.g. $Cu^{2+} + 2e^{-} \rightarrow 2Cu$.

(d) Jewellery, corrosion or rust protection were the three most common correct answers.

CHEMISTRY

Paper 5070/31
Practical Test

Key messages

- Success in this paper required candidates to meet the practical and mathematical demands of a volumetric exercise.

- The examination's qualitative tasks involved test-tube observations, a gas identification and conclusions regarding the identity of the compounds in unknown aqueous solutions. Candidates competent in volumetric calculations, 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**, although very few successfully used the data generated in answering the related calculations.

While all the learners 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 usually properly completed, although a few readings were not given to sufficient precision. Concordant titres were nearly always selected and titre accuracy, although generally good, varied by centre. Two concordant titres are sufficient.

Some candidates attempted all the calculations that followed, although few scored many of the marks available.

(b) While some candidates struggled to calculate the concentration of sulfuric acid, there were others who competently produced the correct answer to three significant figures. The common errors seen were associated with not using the mole ratio in the given equation and inverting the pipette and average titre volumes.

(c) Very few candidates appreciated that 250 cm^3 of **P** had been prepared from 5.0 cm^3 of concentrated sulfuric acid. As a result, many calculated the number of moles of H_2SO_4 in 5.0 cm^3 rather than in 250 cm^3 of the dilute acid.

(d) Despite having the incorrect answer in **(c)**, many candidates multiplied it by 200 and scored an error carried forward mark in **(d)**. A comparison of the concentrations of the acid here and in **(b)** should have led some to review their previous calculation.

(e) Whilst many realised that obtaining the answer to this question involved multiplying by 98, there were a few who ignored the instruction to use their answer from **(d)** and used another one instead.

Many error carried forward marks were awarded.

Question 2

All the points in the mark scheme were awarded in the assessment of the examination scripts.

Candidates should be encouraged to make full use of the Qualitative Analysis Notes supplied. There was much imprecision in the way candidates expressed the observations in two-stage tests involving the addition of firstly a few drops of and then excess reagent. For example, the unqualified phrase 'soluble precipitate' in the context of a longer response is unclear.

(a)

Test 1

A blue precipitate was generally seen in **(i)** and remained in excess alkali in **(ii)**.

Test 2

The observation in **(i)** usually mirrored that in **Test 1**. A few candidates mentioned a dark blue precipitate here. A description of dissolving or a dark blue solution were often seen in **(ii)**, though not always in both. Part **(iii)** proved to be the most challenging of the tests. More noted the change in colour of the solution on addition of the hydrogen peroxide than the bubbling of the mixture. Whether they recorded effervescence or not, there were as many who identified an alkaline gas being produced as one which relit a glowing splint. Most of the latter, identified the gas as oxygen but the noisy relighting of a glowing splint occasionally led to hydrogen being suggested.

Test 3

Candidates frequently performed well in these tests but there were a few who made no response for **(i)** or who incorrectly used descriptions such as white or milky solution, or cloudy or milky precipitate.

(b) Candidates often had sufficient evidence to correctly identify the compound in **R** but did not secure the mark. A significant number chose to provide the name or formula of the metal ion only. A few named **R** imprecisely as copper chloride.

(c)

Test 1

While there were a few who saw no precipitate at any stage, presumably because the alkali was added too quickly, the majority reported a white solid in **(i)** and generally found it dissolved in excess in **(ii)**. The description of the final solution as colourless was not always included.

Test 2

A white precipitate in **(i)** which was insoluble in excess ammonia in **(ii)** was reported by many, but some asserted that the precipitate was soluble. No reaction with hydrogen peroxide was reported by many in **(iii)** but some provided observations indicating a gas was evolved.

Test 3

Candidates frequently performed well in these tests but there were a few who made no response for **(i)** or who incorrectly used descriptions such as white or milky solution, or cloudy or milky precipitate.

(d) Candidates often had sufficient evidence to correctly identify the compound in **S** but did not secure the mark. A significant number chose to provide the name or formula of the metal ion only. A few thought that the metal ion in **S** was zinc even though the test observations were completely correct.

CHEMISTRY

Paper 5070/32
Practical Test

Key messages

- Success in this paper required candidates to meet the practical and mathematical demands of a volumetric exercise.

- The examination's qualitative tasks involved test-tube observations, a gas identification and conclusions regarding the identity of the compounds in unknown aqueous solutions.

- Candidates competent in volumetric calculations, 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**, although very few 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 usually properly completed, although a few candidate's readings were not given to sufficient precision. Concordant titres were nearly always selected and titre accuracy, although generally good, varied by centre. Two concordant titres are sufficient.

Some candidates attempted all the calculations that followed, although few gained many of the marks available.

(b) While some candidates struggled to calculate the concentration of nitric acid, there were others who competently produced the correct answer to three significant figures. The common errors seen were associated with not using the mole ratio in the given equation and inverting the pipette and average titre volumes.

(c) Very few learners appreciated that 250 cm^3 of **P** had been prepared from 5.0 cm^3 of concentrated nitric acid. As a result, many calculated the number of moles of HNO_3 in 5.0 cm^3 rather than in 250 cm^3 of the dilute acid.

(d) Despite having the incorrect answer in **(c)**, many candidates multiplied it by 200 and gained an error carried forward mark in **(d)**. A comparison of the concentrations of the acid here and in **(b)** should have led some to review their previous calculation.

(e) Whilst many realised that obtaining the answer to this question involved multiplying by 63, there were a few who ignored the instruction to use their answer from **(d)** and used another one instead.

Many error carried forward marks were awarded.

Question 2

All the points in the mark scheme were awarded in the assessment of the examination scripts.

Candidates should be encouraged to make full use of the Qualitative Analysis Notes supplied. There was much imprecision in the way candidates expressed the observations in two-stage tests involving the addition of firstly a few drops of and then excess reagent. For example, the unqualified phrase ‘soluble precipitate’ in the context of a longer response is unclear.

(a)

Test 1

A green precipitate was generally seen in **(i)** and remained in excess alkali in **(ii)**.

Test 2

The observations in **(i)** and **(ii)** usually mirrored those in **Test 1**. A few candidates mentioned a blue precipitate here. Part **(iii)** proved to be the most challenging of the tests. More noted the change in colour of the precipitate on addition of the hydrogen peroxide than the bubbling of the mixture. Whether they recorded effervescence or not, there were as many who identified an alkaline gas being produced as one which relit a glowing splint. Most of the latter identified the gas as oxygen but the noisy relighting of a glowing splint occasionally led to hydrogen being suggested.

Test 3

Candidates frequently performed well in these tests but there were a few who made no response for **(i)** or who incorrectly used descriptions such as white or milky solution, or cloudy or milky precipitate.

(b) Candidates often had sufficient evidence to identify correctly the compound in **R** but did not secure the mark. A significant number chose to provide the name or formula of the metal ion only. A few named **R** insufficiently precisely as iron sulfate.

(c)

Test 1

While there were a few who saw no precipitate at any stage, presumably because the alkali was added too quickly, the majority reported a white solid in **(i)** and generally found it dissolved in excess in **(ii)**. The description of the final solution as colourless was not always included.

Test 2

A white precipitate which dissolved in excess ammonia was reported by many but once again the description of the final solution was missed by some. There were a number whose solid remained in **(ii)**, presumably because they did not add sufficient ammonia or agitate the mixture enough. No reaction with hydrogen peroxide was reported by many in **(iii)** but some provided observations indicating a gas was evolved.

Test 3

Candidates frequently performed well in these tests but there were a few who made no response for **(i)** or who incorrectly used descriptions such as white or milky solution, or cloudy or milky precipitate.

(d) Candidates often had sufficient evidence to identify correctly the compound in **S** but did not secure the mark. A significant number chose to provide the name or formula of the metal ion only. A few thought that the metal ion in **S** was aluminium even though the test observations were completely correct.

CHEMISTRY

Paper 5070/41
Alternative to Practical

Key messages

- Candidates continue to need more experience in writing their own experimental methods.

General comments

Responses were very varied across the entry.

When answering questions where observations are required it is important that candidates describe what they would see in the experiment.
Observations include:

- colours and changes in colour
- effervescence
- solids dissolving or disappearing
- precipitates forming.

Comments on specific questions

Question 1

(a) This was well answered. A number of candidates thought it was a gas jar.

(b)(c) These questions tested candidate's ability to link the data provided to the methods for collection of a gas. It was important that candidates related their answer to the specific property in the question rather than mentioning all properties. Most candidates found these straight forward.

Question 2

(a) A number of candidates did not appear to be familiar with electrolysis.

Many candidates did not correctly understand the term 'observation'. When answering questions where observations are required it is important that candidates describe what they would see in the experiment. For example, 'effervescence of a green gas' is an observation but 'chlorine is produced' or 'the gas relights a glowing splint' is a conclusion based on the data.

(b) (i) The test for chlorine was generally well known. A few candidates thought that litmus turned blue before being bleached. Other candidates suggested using the silver nitrate test for chloride ions.

(ii) Few candidates mentioned the use of a fume cupboard, with many suggesting generic safety precautions such as goggles or gloves instead. Some suggested gas masks but this is not considered an appropriate safety measure for normal school laboratory experiments.

Question 3

(a) Most candidates could identify a conical flask.

(b) (i) Most candidates were familiar with the limewater test. Descriptions such as 'milky' were accepted as an alternative to 'white precipitate' in this context but generally should be avoided.

(ii) The important point to make in answering this question is realising that the mass decreases because the gas leaves the conical flask. Many candidates thought that the mass was reduced because the reaction took place or because a gas was made and did not make it clear that the gas was lost from the container. Answers which implied there was no conservation of mass in an experiment were not acceptable.

(iii) The most obvious way of monitoring this experiment is by measuring the volume of gas produced. However, other alternatives were acceptable if they were practically possible and would allow for the determination of rate. For example, monitoring the change in concentration of acid (by a sampling method); monitoring pH change; counting bubbles etc.

(c) Particle size/surface area and temperature were common correct answers. Some candidates were confused about which mass needed to be controlled and their answers implied that the total mass was kept constant when the experimental technique clearly shows the mass changing. Other candidates suggested concentration when the table showed that this was changing.

(d) (i) Good answers were clearly linked to the graph and explained how it related to identifying the fastest rate. For example, the 'highest gradient shows the highest rate' gained credit, but 'the gradient shows the rate' did not.

(ii) All orders of letters were given by candidates and some candidates decided to use **ABC** or **123** instead of **X**, **Y** and **Z**. Even when candidates correctly answered **(d)(i)** they often could not apply this correctly to labelling the curves.

(iii) Many candidates answered this correctly. The most common error was to describe the curve as 'straight' rather than 'horizontal'. Straight was an insufficient description of the line.

(iv) This required careful reading of the question to see that the acid was in excess and therefore it is the calcium carbonate that is used up. Many candidates suggested that the acid or the reactants were used up. Some suggested the 'limiting reagent' was used up. Although this is true, it was not credited as candidates were expected to identify the limiting reagent from the information provided.

Question 4

As in previous years candidates continue to find the free response question difficult.

There were a wide range of completely incorrect responses with candidates suggesting preparing potassium chloride by crystallisation; titrating the compounds and measuring titres; connecting gas syringes and measuring volumes of gas; measuring changes in mass etc. A significant number of candidates also disregarded the instruction that no other chemicals can be used.

Candidates who correctly identified that the experiment required the measurement of temperature gained some credit but often did not give sufficient experimental detail such as stirring the mixture and controlling the volume of acid used. Very few candidates were able to link the temperature change measurement to the greater heat change, with many candidates suggesting that potassium carbonate has the greater heat change simply because it was exothermic.

Question 5

(a) Most candidates realised that a pipette is more accurate. Some candidates thought that a pipette can only measure $25.0\,cm^3$ of solution.

(b) Few candidates realised that a volumetric flask is needed. Beakers, conical flasks and measuring cylinders were common incorrect answers.

(c) Many candidates thought that the pipette is washed just with water or distilled water rather than the solution that it is dispensing, which in this case is solution **L**. Some very good responses suggested that it is washed firstly with distilled water and then with **L**.

(d) (i) Most candidates realised that the tile was to help see the colour change. Some candidates thought it was to protect the bench; keep the flask stable or prevent spillage.

(ii) The most common error was to reverse the colours.

(e) The majority of candidates realised that volumes should be expressed to 1decimal place, including 0.0 cm^3.

Some candidates reversed the initial and final volumes.

Others are misreading the diagrams by reading up from the bottom of the diagram rather than down from the top e.g. 24.8 rather than 23.2.

(f) Most candidates were able to calculate this.

(g) Some candidates divided by 2 rather than multiplied.

(h) Many knew how to calculate the number of moles of NaOH.

(i) Few candidates realised that this is the same as **(h)**. Most candidates divided their answer from **(h)** by 10.

(j) Candidates who had managed to reach this stage in the calculations often correctly calculated the concentration of solution **K**.

(k) This was a novel context for candidates and very few were able to answer it. Some correctly suggested that the volume is lower, but many suggested it is larger or unchanged. Those who correctly suggested it was lower often did not give a suitable reason. Many candidates thought that it would be unchanged because indicators cannot take part in reactions

Some of those who tried to give a valid explanation did not seem to have realised that the sodium hydroxide was in the conical flask and the methyl orange was added to it. Many wrote about the methyl orange being added to the acid. A few candidates realised the methyl orange reacted with the sodium hydroxide thus reducing the amount in the flask and hence, less acid was needed.

Question 6

(a) There was a wide range of answers. Candidates' knowledge of these tests was such that they often knew some parts but not others.

(b) Candidates were generally more able to draw conclusions from results that were given than to describe the observations.

Question 7

(a) Many candidates realised that washing was needed but fewer realised that drying is also required.

(b) Some candidates made careless errors. Most were able to draw the graph.

(c) (i) A significant number of candidates misread the scale and gave 1.6 rather than 1.06. Candidates were credited for correct reading from their graph rather than a specific answer.

(ii) Candidates who had drawn two appropriate intersecting lines usually did so correctly.

CHEMISTRY

Paper 5070/42
Alternative to Practical

Key messages

- Candidates should familiarise themselves with the names of pieces of apparatus used in volumetric analysis.
- Choice of the most appropriate pieces of volumetric apparatus for particular tasks is also something that needs to be more familiar to many candidates.

General comments

Candidates still have difficulties with questions that ask them to state the observations or to say what they would see when an experiment is performed. This applied particularly to **Questions 2(b)** and **6(a)**. Observations include:

- colours and changes in colour
- effervescence
- solids dissolving or disappearing
- precipitates forming.

Comments on specific questions

Question 1

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

(b) (i) Many candidates knew that the unsuitability of **Q** to collect gas **B** was caused by the gas being more dense than air. The most common error was to mention that gas **B** was insoluble in water.

(ii) Many candidates knew that the suitability of **P** to collect gas **B** was caused by the gas being insoluble in water The most common error was to mention that gas **B** was more dense than air. Very few candidates mentioned that if **P** was used, it would not be possible to tell when the gas jar was full as **B** is a colourless gas.

(c) The insolubility of **C** in water was a common correct answer. The most common error was to mention that gas **C** is less dense than air.

Question 2

(a) This was answered correctly by the vast majority of candidates.

(b) A variety of colours was seen, especially for iodine. Purple was the only possible colour that correctly corresponded to gaseous iodine. Names of the gases were often given in the space for observations. Unrequired tests for gases were also seen very often. Sulfur or compounds of sulfur were often seen in place of hydrogen.

(c) The test for oxygen was known by many candidates. However, a significant number of candidates stated that oxygen relights a burning splint.

Question 3

(a) This was answered correctly by the vast majority of candidates.

(b) An extremely small number of candidates referred to a thermostatically controlled water bath. A small number mentioned a water bath without thermostatic control. Bunsen burners and electric heaters were seen regularly. Thermometers and various forms of insulation were also very common.

(c) (i) The test for hydrogen was known by most candidates. A small number mentioned a glowing splint.

(ii) Measuring the mass of the flask and its contents was only mentioned by a small number of candidates. Temperature and time were amongst the incorrect answers. Measuring the mass of magnesium or the mass of the conical flask (no mention of contents) were both seen quite often.

(d) A variety of correct answers were seen. The most common were concentration and volume of the acid as well as mass and particle size of the magnesium. Temperature and time were again common answers.

(e) (i) Many answers did not refer to the graph. Some stated that the gradient of the graph was related to the rate without saying that the highest gradient represented the greatest rate.

(ii) This was answered correctly by the majority of candidates. A small minority had the letters the wrong way round.

(iii) Many answers did not refer to the graph. When the line is horizontal, it indicates that the reaction has stopped. Some referred to a straight line as opposed to a horizontal one.

(iv) Underneath the table of results, candidates are told that they hydrochloric acid is in excess. This means that the reaction stops because all the magnesium has reacted. Many answers were vague and omitted to refer to the magnesium.

Question 4

Candidates were expected to dissolve the two solids in the same volume of water and measure the temperature change in both cases. Those who were aware of this often omitted stirring to dissolve the solid and omitted to state that the largest temperature change corresponded to the greatest heat change per gram of solid. The final comment was often of the nature that 'the temperature change indicated which substance produced the greatest heat change' without saying precisely how i.e. without reference to the largest change.

Many candidates started by saying, 'add potassium chloride to water' even though the purpose of the experiment was to decide the identity of **A** and **B** and thus it was unknown which bottle contained potassium chloride.

Candidates often wrote about a variety of practical methods which were unrelated to the required investigation. These involved crystallisation; measuring gas volumes and often ended by plotting a graph.

Testing for cations was mentioned even though it was stated no other chemicals were allowed.

Many candidates made suggestions as to which compound produced the greatest heat change per gram of solid. In the absence of any experimental data, it was impossible to draw such a conclusion. There was obvious confusion over greatest heat *change* and most heat *given out*.

Question 5

(a) The majority of candidates correctly chose a burette. Measuring cylinder was the most common incorrect answer.

(b) Volumetric flasks continue to be named by only a small number of candidates. Pieces of glassware, which are not used for measurement, such as beakers and conical flasks were far more common than the correct answer.

(c) Only a small minority of candidates wrote that a pipette filler should be used with a pipette. Various pieces of glassware were mentioned

(d) (i) Very few candidates were aware that a burette should be washed with the solution that will be used in it before filling it with the same solution. Water was by far the most common answer.

(ii) This was answered correctly by a large number of candidates.

(iii) Most of the colours seen were correct. Several candidates gave the colour change the wrong way round.

(e) Almost all the candidates gave the correct burette readings and chose the correct average volume based on concordant results. The biggest error continues to be recording the initial burette reading in titration number 1 as 0 instead of 0.0. If the burette is filled to zero, this should be recorded to the same precision as all the other burette readings.

(f) This was answered correctly by the majority of candidates.

(g) This was answered correctly by the majority of candidates.

(h) This was answered correctly by the majority of candidates.

(i) This part of the calculation showed the greatest error. 20.0 cm^3 of solution **L** contains 0.0107 moles. When this was transferred into a volumetric flask and made up to 250 cm^3 with distilled water, the number of moles of solution **L** the number of moles of **L** is unchanged.

It was extremely common for candidates to divide their answer to **(h)** by (250 ÷ 20).

(j) This was answered correctly by the majority of candidates.

(k) Many candidates knew that the titration volume would be larger. However, only a few gave the explanation that the additional acid caused by an additional amount of methyl orange would require more aqueous potassium hydroxide to neutralise it.

Question 6

(a) A number of candidates gained full credit on this question. Some had most of the answers correct and made occasional errors concerning which precipitates dissolved in excess. However, a small minority left the question blank or filled in the grid with names rather than observations.

(b) This was answered well by many candidates. Chromium(III) was the most common incorrect cation.

Halides other than iodide were occasionally seen as the anion.

Question 7

(a) Most candidates performed well. A frequent error was to leave the anomalous point uncircled, even though the other four points were the only ones used to decide on the straight line of best fit.

(b) (i) This was answered correctly by the majority of candidates.

(ii) Very few candidates referred to the fact that the final temperature would be above the boiling point of water. Many suggested that thermometers only read up to 100 °C.

(iii) Candidates performed poorly on this part as **(b)(ii)** was usually incorrect. Those who said 'choose a liquid with a higher boiling point' needed to be more specific concerning the minimum boiling point required. The same applied to those who said 'use an unspecified lower starting temperature'.