CHEMISTRY

Paper 5070/11
Multiple Choice

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

General Comments

The paper discriminated well between the candidates. It was a good test of candidates' abilities. There were only three questions had very high success rates.

Comments on Specific Questions

Question 1

The most popular alternative was the incorrect option **A.** A final washing of the flask with alkali would increase the volume of acid to be used in the titration and hence give an inaccurate result.

Question 5

All of the molecules had at least one covalent bond with nitrogen having a triple bond between the nitrogen atoms and oxygen a double bond between the oxygen atoms.

Question 10

Statement 1 in the stem of the question was chemically incorrect. Therefore the much favoured alternative **A** was incorrect. If the word negative had been the word positive then the first statement would have been correct.

Question 12

The five in front of the H_2O means that there are in total nine oxygen atoms in the formula and not five. Hence 186 is incorrect.

Question 24

The proportion of oxygen in air is about twenty per cent. Thus **C** was the answer as only oxygen reacts with the steel wool at the top of the test-tube.

Question 28

The catalytic converter does not remove carbon dioxide from exhaust gases; its purpose is to help convert waste gases containing carbon compounds into carbon dioxide

Question 34

Three of the alternatives were almost equally popular with **D** being one of those frequently chosen. Oxygen only forms two compounds which could be classified as hydrides namely water and hydrogen peroxide. From a knowledge of the many alkanes and alkenes, all of which are compounds of hydrogen and carbon only, it was hoped that deduction would lead to the answer **A.**

Question 39

In the substitution reaction with ethane not all of the chlorine is substituted into the ethane, as some of the chlorine combines with the replaced hydrogen to form hydrogen chloride.

CHEMISTRY

Paper 5070/12
Multiple Choice

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

General Comments

The paper discriminated well between the candidates. It was a good test of candidates' abilities. There were only three questions which had very high success rates.

Comments on Specific Questions

Question 3

The most popular alternative was the incorrect option **A**. A final washing of the flask with alkali would increase the volume of acid to be used in the titration and hence give an inaccurate result.

Question 8

Statement 1 in the stem of the question was chemically incorrect. Therefore the much favoured alternative **A** was incorrect. If the word negative had been the word positive then the first statement would have been correct.

Question 26

The proportion of oxygen in the air is about twenty per cent. Thus **C** was the answer as only oxygen reacts with the steel wool at the top of the test-tube.

Question 28

Zinc is above lead in the reactivity series and will reduce lead(II) oxide to lead. In all the other examples the metal of the metallic oxide was higher in the reactivity series than the element trying to react with the oxide.

Question 38

Oxygen only forms two compounds which could be classified as hydrides namely water and hydrogen peroxide. From a knowledge of the many alkanes and alkenes, all of which are compounds of hydrogen and carbon only, it was hoped that deduction would lead to the answer **A.**

Question 40

In a reaction between an alkane and chlorine, the gas hydrogen chloride is formed as well as the chloroalkane.

CHEMISTRY

Paper 5070/21
Theory

Key messages

- Answers to quantitative questions should include clear working out.
- It is better to attempt an answer than to leave the space blank as credit cannot be awarded for a blank space.
- Candidates should be advised to read the questions carefully before starting their answer.

General Comments

Most candidates followed the rubric of the question paper and attempted just three questions from ***Section B***. A small proportion of candidates attempted all four questions from ***Section B*** and then crossed out their answers to one of these questions. All four questions in ***Section B*** were equally popular.

A significant proportion of the candidates left whole questions blank.

Candidates often found the short answer questions less challenging than those which required extended answers. Good answers used the correct chemical terms and/or illustrated answers with clear labelled diagrams. Some candidates gave imprecise and vague extended answers; these candidates could be advised to use bullet points rather than writing in paragraphs.

Good answers to quantitative questions included clear working out so that credit could be awarded for error carried forward.

Comments on Specific Questions

Section A

Question A1

Most candidates attempted these questions.

(a) Many candidates correctly gave sulfur dioxide as the bleach used in the manufacture of paper.

(b) A significant proportion of the candidates recognised potassium manganate(VII).

(c) Candidates often did not recognise silver nitrate; calcium hydroxide was a frequent incorrect answer.

(d) Although many candidates chose nitrogen dioxide, both carbon monoxide and sulfur dioxide were also chosen.

(e) Many candidates recognised methane as a gas produced by the decay of vegetable matter.

Question A2

Many candidates found the unusual context for **(a)** and **(b)** difficult to interpret.

(a) Only a very small proportion of the candidates deduced the empirical formula as C_2H_4O. A significant proportion of the candidates wrote down the molecular formula for the crown ether. Other candidates gave the empirical formula as $C_2H_4O_2$.

(b) A significant proportion of the candidates gave the structure of Na^+ rather than Na^- and did not appreciate that the Na^- did not have a stable electron arrangement.

(c)

(i) Many candidates repeated the information given in the stem of the question rather than giving the actual observations. The most common observations given were that the sodium floated on the water and that there was some fizzing. Candidates sometimes mentioned the presence of a flame but did not give the colour of the flame.

(ii) Many candidates were not able to write the correct equation and as a result could not be awarded credit for the correct state symbols. Common misconceptions included the use of Na_2 or the formula being $Na(OH)_2$. Candidates often gave the correct state symbols if they had the correct formulae. The most common error was to use $H_2O(aq)$ rather than $H_2O(l)$.

(d)

(i) Many candidates appreciated that the melting point of iron was higher than that of sodium. A small proportion of the candidates did not make comparative statements, for example stating that the melting point of sodium was low; these types of answers were not given credit.

(ii) Many candidates appreciated that the density of iron was higher than that of sodium. As in **(i)** some candidates did not make comparative statements.

Question A3

This question focused on the reaction between hydrogen peroxide and iodide ions.

(a)

(i) Although some candidates were able to explain that iodide ions gave away electrons and so iodide was a reducing agent, other candidates had the misconception that iodide gains electrons to get iodine. A small proportion of candidates used the change in oxidation number for their explanation. Another common misconception was that hydrogen was reduced.

(ii) Some candidates were able to state the correct colour change but a significant proportion gave the colour of iodide as a purple solution rather than a brown solution.

(b) Many candidates attempted to interpret the data in the table and most of these found the effect of potassium iodide easier than the effect of sulfuric acid. Good answers referred to the data in the table within their answers quoting the change in concentration and the resulting change in speed of reaction. Some candidates did not appreciate that they had to compare experiments where only one variable was changed and as a result gave answers in which the speed of reaction increased and then decreased.

(c) A significant proportion of candidates did not use collision theory to explain why decreasing the temperature decreases the speed of reaction. Candidates needed to refer to the particles moving slower or having less kinetic energy and hence having more successful collisions. Candidates often did not mention particles in the answer or just referred to more collisions.

(d) Many candidates were able to gain at least partial credit for this question but most could not get all the numbers correct. Candidates were much more likely to get the number of protons or the number of neutrons correct than the number of electrons because candidates often did not appreciate that the particle was an anion.

Question A4

Candidates found this question about chromatography very demanding.

(a)

(i) A significant proportion of the candidates did not attempt this question. Most candidates obtained all of their credit from the labelled diagram. A common misconception was to put the paper into the brown solution rather than the solvent. Another misconception was to show a chromatogram with several different compounds rather than just the brown solution.

Many candidates had diagrams in which the spot would have been washed off by the solvent.

(ii) Many candidates did not attempt this question often because they could not answer **(i)**. Good answers referred to the comparison of R_f values. Common misconceptions involved using fractional distillation or testing the chlorophyll with iodine.

(b)

(i) Many candidates could recall the equation for photosynthesis.

(ii) Candidates found this a very demanding question. Many candidates did not include electrons in their equations and so could not be awarded credit.

(c)

(i) Many candidates correctly referred to the presence of a double bond. In this example the mark scheme did not require the reference to a carbon-carbon bond but nevertheless many candidates included this in their answer.

(ii) Many candidates could apply their knowledge of the test for unsaturation and gave the correct colour change.

(d)

(i) Many candidates could recall the general formula for an alkene.

(ii) A significant proportion of the candidates were able to draw the structure of the alkene. Most drew but-1-ene or but-2-ene. A common misconception was to draw butane or to draw structures in which each carbon atom was bonded to two hydrogen atoms.

(iii) The conditions for the hydration of ethene were not well known and often the wrong temperature was given.

Question A5

Candidates found this question about the different types of bonding extremely demanding.

(a)

(i) Many of the drawings by candidates did not include labels although the use of a circle surrounding a positive sign and ‘e’ were sufficient to identify the positive ion and the electrons. Good answers had the positive ions in a regular pattern with the electrons shown and labelled as delocalised electrons.

(ii) Candidates were able to explain why metals conduct electricity and there were many clear answers involving free electrons or delocalised electrons. Candidates had much more difficulty explaining why metals are malleable and many candidates did not refer to a force being applied.

(b) Candidates were often able to explain why silicon dioxide does not conduct electricity in terms of the lack of free electrons but found it much more demanding to explain why it is hard. It was not sufficient to refer to the strong covalent bonds; candidates had to refer to either the giant nature of the structure or that there were many strong covalent bonds.

(c) Only a very small proportion of the candidates deduced the empirical formula as $PdCl_2$. A significant proportion of the candidates wrote down the formula for the structure shown.

(d) Candidates often appreciated the significance of ions that could move but a significant proportion of candidates referred to the presence of moving electrons in molten sodium chloride.

Section B

Question B6

Candidates found this question about the preparation of hydrated sodium sulfate extremely demanding.

(a) Candidates that attempted this question often described how the dry crystals could be obtained from an aqueous solution but did not describe how the neutral aqueous solution was obtained. Candidates often neglected to include the use of an indicator to find the volume of acid or alkali needed to neutralise and then the need to repeat the experiment using these same volumes.

(b) Only a very small proportion of candidates were able to calculate that the mass of sodium sulfate crystals would be 6.44g. Good answers were clearly laid out in a logical fashion. A significant number of candidates were not able to calculate the relative formula mass of hydrated sodium sulfate and others did not use the volume and concentration of sodium hydroxide to determine the amount in moles of sodium hydroxide.

(c) A significant proportion of the candidates used a physical test such as the melting point rather than a chemical test for water. Candidates who used a chemical test used cobalt chloride or copper sulfate but often did not describe the exact nature of the reagent e.g. white copper sulfate. If a correct reagent was chosen, candidates were highly likely to be awarded credit for the observation.

Question B7

Candidates tended to find this question more accessible than **B6** because there were no long questions.

(a) Candidates named the two functional groups but sometimes the atoms were given rather than the names.

(b) Only a very small proportion of the candidates could balance the equation. Many candidates did not appreciate that the –OH group of the glycolic acid remained intact in the product and that the –-CO_2H group reacted. Candidates often realised that carbon dioxide was produced even if the equation was not balanced.

(c) Good answers referred to the gain of hydrogen or the loss of oxygen from the glycolic acid.

(d)

(i) Most candidates incorrectly chose an addition polymer rather than a condensation polymer, but those that did chose the condensation polymer were able to explain that this was because of the ester linkage or because water was produced during the formation of the polymer.

(ii) The most common correct response was Terylene. Incorrect answers included nylon and poly(oxalic acid).

(e)

(i) Although many candidates understood what a biodegradable polymer was they were unable to give acceptable environmental advantages. A common misconception was that a biodegradable polymer would not give toxic gases rather than there is no need to dispose of the polymer by burning. The most common correct answers involved the reduction of litter and the lack of need for land-fill sites.

(ii) Many candidates recalled that poly(ethene) is used to make plastic bags; a common misconception was that it was used to make nylon containers.

(iii) Candidates often gave the structure of part of a section of the polymer instead of drawing the structure for propene.

Question B8

This question was about aluminium.

(a)

(i) Many candidates appreciated that aluminium oxide was an amphoteric oxide.

(ii) Many candidates were not able to write the correct formulae and as a result could not construct the balanced equation.

(iii) Many candidates were able to use the information in the stem to suggest filtration.

(b)

(i) Candidates were more likely to be able to write the ionic equation for the reaction at the cathode than the one at the anode. A common misconception involved the gain of electrons at the anode rather than the loss of electrons. A significant proportion of candidates could not write the formula for the oxide ion.

(ii) Candidates were often able to explain why cryolite was added to aluminium oxide; however a common misconception was that cryolite was a catalyst.

(c)

(i) Candidates were often able to give one reason for the use of aluminium rather than iron however many candidates referred to aluminium rusting rather than corroding. A significant proportion of the candidates referred to the protective layer of aluminium oxide surrounding the surface of the aluminium.

(ii) Although many candidates were able to explain that an alloy was a mixture of metals, a significant proportion referred to a compound between metals.

Question B10

This question was about the hydrogen halides.

(a)

(i) Candidates were able to calculate the volume of hydrogen chloride as 4.8 dm^3 or 4800 cm^3. A small proportion of candidates used the molar gas volume at STP rather than RTP.

(ii) Many candidates could draw the 'dot-and-cross' diagram for hydrogen chloride.

(b) A significant proportion of candidates did not write the correct formulae and as a result could not write the balanced equation. Typical errors included H_2F_2 or HF_2 for hydrogen fluoride. A small number of candidates tried to write an equation involving the formation of calcium hydrogen sulfate but used the formula $CaHSO_4$ rather than $Ca(HSO_4)_2$.

(c) Many candidates showed a good understanding of the strength and pH of the two acids however a common misconception was that the stronger acid would have a higher pH.

(d)

(i) Many candidates were unable to use Le Chatelier's principle to predict the position of equilibrium would shift to the right. A significant proportion of the candidates referred to the speed of reaction increasing rather than the position of equilibrium.

(ii) Only a very small number of candidates could calculate the correct percentage of 10 %. Many candidates calculated the percentage by moles. Other candidates were not able to calculate the correct molar masses, for example these candidates used the molar masses for H, I and 2HI rather than H_2, I_2 and HI.

CHEMISTRY

Paper 5070/22
Theory

Key Messages

- The basic knowledge of simple inorganic chemistry was good. More practice is required in writing formulae of simple inorganic compounds.
- More detail is required when writing extended prose in questions about environmental aspects of chemistry, especially acid rain and the effect of alkalis on ammonium salts.
- Aspects of physical chemistry such as strong and weak acids were well understood, whilst explanations of diffusion needed more detail.
- Calculations, especially in ***Section B***, were generally done well, while some candidates need to revise the application of Avogadro's Law.
- Some candidates need more practice at answering questions about practical aspects of chemistry, for example, salt preparation and measurement of reaction rates.

General Comments

Many candidates tackled this paper well in both ***Sections A*** and ***B***. Aspects of inorganic chemistry were generally well answered. The writing of balanced equations was not always successful, a major obstacle for some candidates being to work out the formula of simple species such as barium hydroxide and calcium nitrate. Questions involving physical properties were generally well done. Practical aspects of chemistry e.g. **Questions B7(d)(i)** (following the course of a reaction) and **B9(d)** (preparation of a salt by precipitation) posed challenges for many candidates. The answers to the latter were often written in a confused manner and with the stages in an incorrect sequence. Good answers were seen in **Questions A1**, **A4** and **B6**. In general, ***Section B*** questions were as well answered as those in ***Section A***, the question on barium compounds, **B9**, proving the most demanding of these.

The majority of candidates attempted most parts of each question in ***Section*** **A**. The exception was the question on the separation of oxygen and nitrogen, **A2(a)(ii)**, where some did not respond. In ***Section B*** some candidates gave answers of the appropriate length to questions involving free response. Others wrote only one or two sentences, where 3 or 4 separate points were required for an answer. The standard of English was generally good.

Some candidates disadvantaged themselves by writing vague answers or repeating themselves in questions requiring a specific number of answers. This was especially apparent in questions on environmental chemistry e.g. **A3(e)** and **A4(b)(i)**. Most candidates' knowledge of structure and properties in terms of atoms, ions and electrons was fairly good. Many candidates were able to explain electrical conduction in metals and the difference between strong and weak acids. Many could write electronic structures of ions (MgO) and molecules (acetylene). Others did not use all the information provided (3 pairs of electrons between the carbon atoms in acetylene). Many candidates found the question on organic chemistry (**Question B8**) challenging. There were a few good descriptions of the bromine water test for unsaturation and successful calculations of the empirical formula of carboxylic acid X. Fewer candidates gained credit for constructing the equation for the reaction of ethanoic acid with sodium, giving the full structure of butanoic acid or working out the molecular formula of carboxylic acid X.

Many candidates performed well in questions involving calculations. Many showed appropriate working and clear indications about what each number referred to. In order to gain credit, candidates should make it clear why they are performing certain steps, rather than writing a mass of figures. Many relatively weak candidates were able to gain full credit for some of the calculations.

The rubric was generally well interpreted, the exceptions being in **Question B8(c)(ii)**, where candidates did not refer back to carboxylic acid X from the previous question and **Question B9(d)** where many candidates thought that a mixture of barium nitrate and barium sulfate was being provided.

In ***Section B*** **Question B9** was the least popular.

Comments on Specific Questions

Section A

Question A1

This question was generally well answered. Some candidates seemed convinced that sodium was an answer to one or more of the questions, even though it was not a correct answer for any of them.

(a) This was generally correct. The commonest error was to suggest calcium.

(b) Most candidates realised that nickel is the catalyst in the hydrogenation.

(c) This was the least well answered part of this question. Iodine was the commonest incorrect answer, but sodium, calcium and hydrogen were also commonly seen.

(d) This was well answered

(e) Many candidates realised that hydrogen is released at the cathode when a dilute aqueous solution of sodium chloride is electrolysed. A significant minority did not appear to read the 'aqueous' in the stem of the question and suggested sodium.

(f) This was generally well answered. The commonest errors were to suggest calcium or sodium.

Question A2

Many candidates performed well in this question. Parts **(a)(i)**, **(d)** and **(e)(ii)** were particularly well done. Other candidates need to give more focused explanations in the questions about the separation of the components in air **(a)(ii)** and the ozone layer **(e)(ii)**. Some candidates did not use the information about acetylene to construct the 'dot-and-cross' diagram and others made simple errors in drawing the electronic structure of magnesium oxide.

(a)

(i) Most candidates knew the correct percentage of oxygen in the air. The commonest errors were 79 % or 80 % (confusion with nitrogen), values near 21 % (16 % and 22 % were not uncommonly seen) or values between 27 % and 30 %.

(ii) About half the candidates realised that the air had to be liquefied first. A large minority thought that the air was just heated up and distilled. Fewer candidates gained credit for separation according to different boiling points. Most were content to describe distillation rather than explain why the gases can be separated. Some candidates left the question unanswered.

(b) Some candidates gave good answers such as 'used in welding for cutting and joining metals'. Others gave rather vague answers such as 'for melting metals' or 'for joining'. Many candidates had no idea of what acetylene is used for. Common incorrect answers included for blast furnaces, for heating, for fuel, for making glass, in recycling or to melt things.

(c) Many candidates used the information in the question and drew good 'dot-and-cross' diagrams of acetylene. Others did not use the formula given and drew incorrect numbers of C and H atoms, sometimes with 3 carbon atoms overlapping each other in a triangle. Common errors included extra electrons being placed between the bonding electrons, structures based on ethene or adding an extra electron to each hydrogen atom.

(d) The 'dot-and-cross' diagram of magnesium oxide was generally well drawn. Candidates who gained partial credit, usually got it for the correct charges. The commonest errors related to the electron shells; two electrons remaining in the outer shell of the magnesium ion, too many inner shells - the structure 2,8,8 was not uncommonly seen or incorrect use of arrows showing transfer of electrons from the magnesium atom to the oxygen atom.

(e)

(i) Some candidates wrote correctly-balanced equations. Most others wrote isolated oxygen atoms on the left hand side. A considerable number wrote ozone as O_5 by combining O_2 with O_3.

(ii) Many candidates gained credit for this question. Some omitted ultra-violet and just wrote about 'radiation from the sun' or 'sunlight'. A few gave the incorrect radiation, infra-red being the commonest incorrect form. Others did not mention why the ultraviolet radiation was dangerous or gave the vague answer 'skin diseases'.

Question A3

Many candidates gave good, detailed answers to most parts of this question. The stronger candidates were generally able to do the calculation in **(d)** but most did not understand that they had to use the mole ratios to work out the gas volumes.

(a) Many candidates gave a good definition of a hydrocarbon. The commonest error was the omission of the word 'only'.

(b) This was almost invariably correct. A few candidates gave the incorrect formula C_7H_{18}.

(c) Most candidates identified the correct word as 'isomers'. The commonest errors were 'isotopes' or 'allotropes'. 'Monomers' and 'polymers' were occasionally seen.

(d) Some candidates realised that they had to use Avogadro's Law to relate the volumes of gases to the mole ratios in the equation. Most candidates did complicated calculations which resulted in incorrect answers, sometimes greater than the total volume of gases e.g. 600 cm^3. Fewer candidates gained credit for the correct volume of oxygen remaining than for the volume of carbon dioxide.

(e) Many answers to this question were well expressed and went into great detail about the combination of carbon monoxide with haem. Most candidates realised that the poisonous gas formed was carbon monoxide. Some candidates did not gain further credit because of vague statements such as 'its harmful', 'uses up oxygen' or 'bad blood flow'. A minority of candidates gave incorrect effects such as 'destroys the ozone layer'.

Question A4

Many candidates tended to repeat themselves or repeat the stem of the question in **(b)(i)** and in **(c)(ii)** many were not awarded credit because they did not know the formula for calcium nitrate.

(a)

(i) Most candidates showed the reactants and products correctly but incorrectly put a double headed arrow or no arrow for the enthalpy change.

(ii) Most candidates knew the test for carbon dioxide. The commonest error was to suggest that carbon dioxide relit a lighted or glowing splint.

(b)

(i) Most candidates realised that sulfur dioxide is formed when the sulfur in coal burns. Some gained further credit for the idea of sulfur dioxide dissolving in rainwater. Many gave the incorrect product formed e.g. 'sulfur dioxide dissolves in rainwater to make sulfuric acid'. Few realised that sulfur dioxide could be further oxidised in the atmosphere and even fewer wrote about sulfur dioxide being an acidic oxide. Many repeated the stem of the question, possibly thinking that it was another marking point.

(ii) Most candidates gave a suitable effect of acid rain. Common errors included 'destroying buildings' or 'destroying plants' or vague reference to animals in the sea or on land.

(c)

(i) Some candidates recognised that lightning is the primary agent causing the combination of nitrogen and oxygen in the atmosphere. Others gave incorrect answers such as 'high pressure', 'low pressure' or 'temperature'. Some tried to link the reaction to the Haber process.

(ii) Many candidates wrote the formula incorrectly as $CaNO_3$ and others suggested that hydrogen is formed in the reaction rather than water.

Question A5

Parts **(b)** and **(d)(ii)** were answered well by most candidates. The diffusion question, **(b)(ii)**, was often answered using repetition of rather vague statements. In **(c)(i)** many candidates did not realise that the particles in liquids are close together and touching each other.

(a) Many candidates gave good explanations of the term *isotope*. A common error was the omission of the word 'atoms'.

(b) Most candidates gave the correct number of protons, neutrons and electrons. Common errors included 81 protons or electrons (from addition of 35 + 46), 34 electrons or muddling up the neutrons with the protons.

(c)

(i) Most candidates gained partial credit, generally for drawing particles in a random manner. Few realised that the particles in a liquid are touching one another. Some could not be awarded credit because, although they showed a number of irregularly arranged particles touching, other particles were drawn which were isolated from the main body of particles.

(ii) There were many detailed responses to this part. Some were good, mentioning diffusion, random movement and collision and mixing of molecules. Others were too vague to award credit. Most candidates gained credit for the word 'diffusion'. Fewer mentioned the random movement of molecules or mixing up of the particles. Some did not mention particles at all and used phrases like 'bromine evaporates' or 'the bromine moves from high to low concentrations'. Many concentrated on intermolecular forces rather than in applying simple kinetic theory.

(d)

(i) Many candidates balanced the equation correctly. Some wrote the incorrect formula for BrF, despite it being given in the question. Others wrote either bromine or fluorine as atoms rather than molecules (although it was rare to see both written as atoms). The equation was often not balanced.

(ii) The calculation was generally done well and relevant working shown. Most candidates calculated the molecular mass of BrF_5 correctly. A common error was to calculate the molecular mass of BrF rather than BrF_5.

Section B

Question B6

Many candidates knew the conditions for the Haber process and the equation for ammonia synthesis.

(a)

(i) Many candidates were able to write the equation for the synthesis of ammonia. Common errors included the formula NH or NH_4 for ammonia and N for nitrogen rather than N_2. Balance was usually correct even if the formulae were incorrect.

(ii) Many candidates knew the conditions for the Haber process. Some omitted the pressure or the catalyst. The commonest errors were giving the temperature in a range going up to 500 ^{o}C, giving the wrong catalyst, usually V_2O_5 or merely stating high temperature and low (or high) pressure.

(b) Most candidates related the use of fertilisers to better growth or higher yield. The commonest errors were to give answers which were too vague e.g. 'for plant growth' or 'to make the soil fertile'. As in previous years a few candidates thought that fertilisers were added to crops to kill insects.

(c) Many candidates knew that ammonia was given off. Fewer mentioned a gas or the ammonia escaping from the soil. Many incorrect answers suggested that 'calcium hydroxide neutralises the ammonium solution'.

(d)

(i) The majority of the candidates gained partial credit for this part for mentioning the movement of fertilisers through the soil to lakes and rivers. Few wrote about their solubility in water.

(ii) Most candidates identified eutrophication. The commonest error was to suggest the vague answer 'water pollution'.

Question B7

Many candidates gave good answers to **(a)**, **(b)** and **(c)(i)**. The other parts provided significant challenges, **(d)(i)** often being either not attempted or only a few lines being written. The equation in **(c)(ii)** was successfully completed by more candidates than similar equations in previous sessions.

(a) Most candidates realised the difference between strong and weak acids in terms of extent of ionisation. Some confused acid strength with concentration. Others tried to relate strength to pH or relative reactivity.

(b) Fewer candidates gained credit here in comparison with **(a)**. Many repeated their answers to **(a)** whilst others did not compare the concentration or number of ions present.

(c)

(i) Many candidates realised that hydrogen ions are positive and so are attracted to the cathode. Some did not gain credit because their answers lacked the word 'ions' or just wrote about the 'preferential discharge of hydrogen'.

(ii) Many candidates wrote the correct products (oxygen and water). Fewer put the electrons on the correct side of the equation. Even fewer balanced the equation correctly. The commonest error was to put $+4e^-$ on the left hand side of the equation. Hydrogen was not uncommonly seen as an incorrect product.

(d)

(i) Some candidates wrote good answers and drew clearly annotated diagrams. Others did not draw a diagram. These candidates did not often describe the procedure with sufficient accuracy. Common errors included vague descriptions e.g. 'measure the gas in the syringe' or 'weigh the apparatus at the start and at the end', describing the effects of temperature and of catalysts on the reaction rather than the course of the reaction or implying that the measurements were only taken once.

(ii) The calculation was generally done quite well and many gained full credit. A considerable number of candidates calculated the number of moles of magnesium correctly but did a type of gas law calculation rather than a solution concentration calculation.

Question B8

Some parts of this question on organic chemistry were well answered. The answers to others such as **(a)(ii)**, **(b)(ii)** and **(c)(ii)** indicated that some candidates were not paying sufficient attention to what was being asked.

(a)

(i) Most candidates gave boiling points within the acceptable range. Answers below 175 $^{\circ}$C were rare. Answers between 196 and 200 $^{\circ}$C were more common.

(ii) Many candidates were successful in being able to draw the structure of butanoic acid. The commonest errors were writing the formula for propanoic acid, not writing the bond in the COOH group or placing an alcohol group in the structure as well as a carboxylic acid group.

(iii) Only the stronger candidates were able to balance the equation. The formula for sodium ethanoate was not well known, an extra H often being added. Water was often given as a product rather than hydrogen. Few candidates balanced the equation.

(b)

(i) Most candidates gave the correct answer, ethyl ethanoate. The commonest incorrect answers were ethenyl ethanoate or ethyl ethenoate.

(ii) The structure of the monomer, ethenyl ethanoate was drawn correctly by about half the candidates. Common errors included a double bond between the carbon atoms or the omission of one of the oxygen atoms in the O_2CCH_3 group.

(c)

(i) Many candidates calculated the correct empirical formula, C_2H_3O. Others rounded up the figures too soon e.g. carbon from 4.65 to 5. Other common errors were finding percentage compositions and dividing by atomic numbers rather than atomic masses.

(ii) Very few candidates understood that the answer to **(i)** needed to be multiplied by 2. Most just wrote the formula for the 4 carbon carboxylic acid, butanoic acid.

(iii) The test for unsaturation using bromine water was well known. Common errors included adding water, adding potassium dichromate, colour changes from colourless to brown or white precipitate being formed (sometimes after adding sodium hydroxide).

Question B9

This was the least popular question chosen by the candidates from ***Section B***. Parts **(b)** and **(c)** were generally well done. Few candidates gained full credit for **(a)(i)** and **(d)**. Many wrote very vague statements about the preparation of a pure, dry sample of barium sulfate, the majority starting off with an incorrect reaction. A considerable number of candidates did not attempt **(d)**.

(a)

(i) Those candidates who wrote the formula of barium hydroxide correctly, often gained at least partial credit. The commonest error was to write BaOH for the formula of barium hydroxide. State symbols were generally correct, the commonest error being to write (aq) for water instead of (l). Water was often seen as a product instead of hydrogen.

(ii) Many candidates gave the equation for hydrogen and hydroxide ions reacting to form water. Some candidates tried to balance the equation by placing a 2 in front of one or other of the species. A considerable minority of the candidates wrote equations including the spectator ions.

(b) This was almost always correct. The commonest incorrect answers were ‘it contains moving ions’ and ‘because it is a metal’.

(c) Most candidates gave good explanations of how aluminium is a reducing reagent in the equation given. When candidates did not gain credit, it was usually because the answer was unclear e.g. ‘barium oxide forms barium’ or inaccurate e.g. ‘aluminium gains electrons’. Some candidates also contradicted themselves.

(d) A few candidates wrote good, clearly-expressed answers with the processes in the correct sequence. Sulfuric acid was the commonest correct compound selected for addition to barium nitrate. Most candidates wrote confusing statements regarding how the barium sulfate is formed. Many thought that they were being given a mixture of barium nitrate and barium sulfate. Others washed the filtrate, evaporated the filtrate or suggested that barium sulfate was the filtrate. Many omitted the washing stage.

CHEMISTRY

Paper 5070/31
Practical Test

Key messages

- As always, candidates should be encouraged to read each question carefully before answering or starting any practical work.
- In quantitative experiments, candidates should repeat the experiment to achieve consistency and then average only the consistent results.
- In qualitative experiments, candidates should be reminded of the importance of making complete and accurate notes of their observations. When a gas is observed this gas should be tested, the observations of the test recorded and the gas identified.

General Comments

There was considerable variation in the performance of the candidates. While some demonstrated capable practical skills in carrying out the titration and recorded and processed the data appropriately, there were others who appeared not to be familiar with the technique. The qualitative tests proved particularly challenging for many. Supervisors are thanked for providing the required experimental data to enable assessment of their candidates' work.

Comments on Specific Questions

Question 1

(a) Candidates were required to record initial and final burette readings to 1 or 2 decimal places, obtain at least two titres within 0.2 cm^3 of the Supervisor's value and then correctly average two or more ticked results that did not differ by more than 0.2 cm^3.

While there were a number who scored performed exceptionally well, there were others whose titres were considerably different from the Supervisor's value. Nevertheless, many of the candidates obtained and selected concordant titres which they correctly averaged.

The remainder of the question, **(b)** – **(d)**, was generally awarded little credit for most candidates.

(b) This was the most successfully completed calculation. There were some who obtained partial credit because they precisely assembled the information in a mathematical equation but could not evaluate the answer correctly. Answers were required to three significant figures and there were a few examples of candidates over-approximating.

(c) In general, candidates did not appreciate that the battery acid was more concentrated than the sulfuric acid that they had titrated. It was rare to find the answer from **(b)** being multiplied by 100.

(d) Despite the previous problem, there were some candidates who correctly worked out the mass of sulfuric acid present in 4.50 dm^3 of battery acid using their concentration from **(c)**.

Question 2

All the scoring points noted in the mark scheme were awarded in the assessment of the examination scripts, although candidates were more successful in securing credit in the first four tests than the latter ones. As in previous years, there were many incomplete, rather than incorrect, answers. It is important that instructions are carefully followed and terms such as 'precipitate' and 'solution' are used precisely. Teachers should continue to encourage candidates to make full use of the qualitative analysis notes supplied on the last page of the exam paper. The terminology and method of reporting provided are a model for the successful recording of observations.

It was not necessary to make all the observations to obtain full credit for this question.

R was aqueous copper(II) sulfate and **S** was copper(I) oxide

Test 1 A white precipitate was produced on addition of aqueous barium nitrate which remained when nitric acid was added in **(b)**. A few believed the precipitate to be blue or described the solution as milky.

Test 2 There were many who recorded the formation of a blue precipitate which dissolved in excess aqueous ammonia to produce a dark blue solution. However, some added the ammonia too quickly and simply noted the solution turned deep blue and there were others who added only enough to produce the blue precipitate.

Test 3 Providing the sodium chloride added is dissolved in **R**, the blue solution turns green. Most recorded the appearance of a blue precipitate when aqueous sodium hydroxide was added to the mixture from **(a)** but not all of these indicated that the solid was insoluble in excess of the alkali in **(b)**.

Test 4 The change in colour of the iron powder to red or brown was more frequently noted than the fading of the blue colour of the solution as the copper(II) ions were displaced. There were some who stated no change occurred, presumably because they did not follow the instruction to mix well.

Test 5 When **S** is warmed with dilute sulfuric acid, the colour of the solid darkens and the solution turns blue. While a number of candidates described the formation of a blue solution, few made comment about the solid remaining in the tube.

Test 6 Initially the same reaction as described in **Test 5** occurs between **S** and dilute nitric acid. The solid formed then reacts with the acid producing bubbles of a yellow or brown gas and the solid gradually disappears. There were some who noted the dissolving of the solid and others who spotted the bubbles but few who recorded the colour of the gas.

Test 7 A white solid is formed as a result of mixing **S** with dilute hydrochloric acid which then dissolves in aqueous ammonia. The final solution is blue. While the colour of the final solution was correctly described by some, there were relatively few who recorded that solid **S** turned white. Again the instruction with regard to mixing must be followed if the test is to be successfully performed.

Test 8 There is little or no reaction between **S** and hydrogen peroxide but once aqueous ammonia is added, there is much effervescence. The gas relights a glowing splint and is therefore oxygen. The final liquid is blue. Many missed the bubbling and few of those who noted it chose to test the gas.

Conclusions

Plenty of candidates recognised that the results from **Test 1** meant that the anion in **R** was sulfate.

While many candidates identified the metal in **R** and **S** as copper, iron featured in a number of answers either on its own or coupled with copper when candidates chose to ignore that **R** and **S** contained the same metal.

CHEMISTRY

Paper 5070/32
Practical Test

Key messages

- As always, candidates should be encouraged to read each question carefully before answering or starting any practical work.
- In quantitative experiments, candidates should repeat the experiment to achieve consistency and then average only the consistent results.
- In qualitative experiments, candidates should be reminded of the importance of making complete and accurate notes of their observations. When a gas is observed this gas should be tested, the observations of the test recorded and the gas identified.

General Comments

The overall standard was good. Most of the candidates were well prepared for the test and demonstrated capable practical skills in completing both the quantitative and qualitative tasks. Supervisors are thanked for providing the required experimental data to enable assessment of their candidates' work.

Comments on Specific Questions

Question 1

(a) Many candidates carried out the titration successfully. Nevertheless, there were a few Centres where the necessary volumetric skills were not sufficiently developed as indicated by the wide range of titres recorded.

Candidates were required to record initial and final burette readings to 1 or 2 decimal places, obtain at least two titres within 0.2 cm^3 of the Supervisor's value and then correctly average two or more ticked results that did not differ by more than 0.2 cm^3.

The table of results was almost always completed correctly and only a few candidates did not tick at least two of their 'best' results.

In the calculations that followed candidates were most successful in (**b**) but relatively few managed to obtain credit in **(c)** and **(d)**.

(b) There were a number of candidates who were able to calculate the correct concentration of hydrochloric acid in **P**. Mistakes generally arose through the inversion of volumes and incorrect use of mole ratios. While there were few examples of over-approximation, i.e. answers were required to three significant figures; a common arithmetic error was to use 0.5 rather than 0.05 as the concentration of **Q**.

(c) It was clear from the attempts at calculation that most candidates did not recognise the acid in the scale-remover was more concentrated than the hydrochloric acid titrated. Dividing the answer from **(b)** by 10 was a common error.

(d) Despite the previous problem, there were some candidates who clearly explained how to calculate the mass of calcium carbonate that can be removed by treatment with a bottle of the scale-remover.

Question 2

All the scoring points noted in the mark scheme were awarded in the assessment of the examination scripts. There was a noticeable improvement upon last year's results. Nevertheless, there were often incomplete, rather than incorrect, answers. It is important that candidates follow the instructions provided e.g. 'You should test and name any gas evolved' requires the test to be described, its result given and the gas named in order to be awarded credit. 'Add a solution until no further change occurs' requires a final statement of what is seen in excess. Candidates should use the terminology and method of expression found in the qualitative analysis notes, as a model for writing observations.

It was not necessary to make all the observations to obtain full credit for this question.

R was manganese(IV) oxide, **S** was manganese(II) chloride and **T** was potassium manganate(VII)

Test 1 Many candidates reported bubbling but not all of these correctly tested for oxygen. A number thought, because of the noisy relighting of the glowing splint, that hydrogen was produced instead of, or as well as, oxygen.

Test 2 Those candidates who followed the instruction 'Allow the mixture to stand' generally recorded the colour of the iodine in the liquid accurately. For those who chose not to wait there were descriptions of yellow, brown and black precipitates which received no credit.

Test 3 The filtrate in **(a)** was yellow as a result of the oxidation of the iron(II) ions by **R**. Consequently the addition of aqueous alkali produced a red-brown precipitate. Many reported a precipitate, though it was not always the correct colour, but few stated that it was insoluble in excess in **(b)**.

Test 4 Almost all candidates recorded the formation of a white precipitate in **(b)** but there were some who did not note the lack of reaction in **(a)**.

Test 5 A precipitate of an acceptable colour was reported by virtually all the candidates in **(a)** but as in **Test 3** relatively few indicated it was insoluble in excess of the alkali. With the addition of hydrogen peroxide, most noticed the darkening of the precipitate and the bubbling but the gas was not always identified.

Test 6 The addition of hydrogen peroxide causes **T** to turn colourless and bubbles to be seen in the liquid. Almost all candidates reported one of these observations and many both. If the contents of the test tube were not sufficiently mixed, candidates did not state 'turns colourless'. It was, however, pleasingly rare to find 'goes clear' as an alternative to this observation.

Test 7 The result of carrying out the instruction in **(a)** is a green filtrate. While there were plenty of candidates who noted the correct colour, it was at times associated with a precipitate or the filter paper rather than a liquid. Those who reported a green colour usually noted the colour change on addition of the acid in **(b)**. A significant number thought there was no reaction in (**a**) or **(b)** suggesting that they did not follow the instructions carefully enough.

Conclusions

Most candidates identified the anion in **S** as chloride.

There were candidates who correctly reported that both **R** and **T** acted as oxidising agents in the specified tests but it was clear that despite the evidence, some felt the need to have different conclusions for **R** and **T** so reducing agent was often suggested.

CHEMISTRY

Paper 5070/41
Alternative to Practical

Key messages

- Candidates should be advised to read the question carefully before answering.
- Candidates should be advised to attempt each question as credit cannot be given for blank answers.
- The number of marks shown and the amount of space provided give a guide to the length of answer required, and candidates who exceed the space provided may be wasting time giving unnecessary or irrelevant detail. It is helpful if candidates confine their answers to the space provided; if their answer continues elsewhere on the paper this should be made clear.

General Comments

The Alternative to Practical Chemistry paper is designed to test the candidate's knowledge and experience of practical chemistry.

Skills including recognition and calibration of chemical apparatus and their uses, recall of experimental procedures, handling and interpretation of data, drawing of graphs, analysis of unknown salts and calculations are examined.

The standard continues to be maintained and the majority of candidates show evidence of possessing many of the aforementioned skills.

Most candidates show competency of plotting points accurately on graphs and joining the points as instructed.

Calculations are generally completed accurately using the appropriate significant figures.

Comments on Specific Questions

Question 1

Most candidates correctly read the volume as 26 cm^3.

Question 2

(a) The litmus changes from red in acid to blue in alkali. A number of candidates reversed the colours.

(b) The gas formed is hydrogen. When testing for hydrogen a lighted (not glowing) splint should be used that produces a pop.

(c)

(i) When calcium carbonate is added to hydrochloric acid, effervescence or bubbling is observed. A suggestion that gas evolved is insufficient as this is stated in the question.

(ii) The gas evolved was usually correctly identified as carbon dioxide and the lime water test was well known.

Question 3

(a) Most candidates correctly calculated the mass of magnesium as 0.48 g.

(b) The appearance of magnesium and magnesium oxide was not well known. Magnesium is a grey or silver solid or metal and magnesium oxide is a white solid or powder. The colours alone are insufficient to gain credit.

(c) The crucible is reheated, cooled and reweighed to ensure that the reaction is complete.

(d) The mass of magnesium oxide is 0.8 g and that of magnesium 0.32 g.

(e) To get credit for the correct formula MgO, the calculation must show how the answers to **(a)** and **(d)** are used.

(f) The equation given can involve any acid to produce the corresponding salt and water. Some candidates included hydrogen as a product rather than water. The equation suggests that magnesium oxide is a basic oxide.

Question 4

Ammonia cannot be collected by displacement of water as it is soluble thus it is collected as shown as it is less dense than air. The correct answer is **(c)**.

Question 5

Ethanol does not conduct electricity. The correct answer is **(b)**.

Question 6

Copper reacts with oxygen in the air. As air contains approximately 20 % of oxygen the volume of gas remaining will be about 80 cm^3. The correct answer is **(d)**.

Question 7

When calcium carbonate reacts with hydrochloric acid only the volume of the solution remains unchanged. The correct answer is **(d)**.

Question 8

The solubility curves show that potassium nitrate is more soluble than ammonium sulfate above 50 ºC. The correct answer is **(b)**.

Question 9

(a) Most candidates correctly calculated the mass of impure magnesium carbonate as 1.22 g.

(b) Very few candidates realised that the reaction should be done in a beaker to allow the escape of carbon dioxide gas.

(c) The colour change at the end point is from red or orange to yellow.

(d) The three titres are 24.1 cm^3, 23.5 cm^3 and 23.7 cm^3. As usual, when errors occur in reading the burette diagrams or subtracting the volumes, the mean must be taken from the closest two titres. A common error is to use all three titres in calculating the mean.

The calculations were generally well done. Errors could be carried forward throughout this question and if used correctly further credit could be gained. The answers are:-

(e) 0.00236 moles

(f) 0.00236 moles

(g) 0.0236 moles

(h) 0.05 moles

(i) 0.0264 moles

(j) Many candidates gave the correct equation. Others had incorrect formulae for magnesium compounds or the equation was not balanced.

(k) 0.0132 moles

(l)

(i) 84

(ii) 1.11 g

(iii) 91 %

Question 10

This question involves the analysis of copper(II) chloride. The reactions were generally well known.

(a) A coloured solution indicates that a transition metal ion is present in compound **S**. Candidates who stated that **S** is a transition metal were not awarded credit.

(b) When sodium hydroxide is added a blue precipitate is formed which is insoluble in excess.

(c) When aqueous ammonia is added a blue precipitate is formed which is soluble in excess forming a deep blue solution. The colour of the solution was required for further credit to be awarded.

(d) The presence of chloride ions is confirmed by adding nitric acid and aqueous silver nitrate to the solution. No test or observation credit can be obtained if silver nitrate is not used or if hydrochloric acid is used instead of nitric acid. The correct formula for **S** was usually given.

Question 11

(a) Candidates were asked to read the thermometers and calculate the temperature rises and this was generally done well.

(b) The results should be plotted on the graph. Candidates are given credit for plotting the points accurately and joining them with two intersecting straight lines, the first of which should pass through zero. Most candidates performed well here.

(c)

(i)(ii) The correct answers are 0.34 g and 0.70 g however credit was given for the candidate reading their own graph correctly.

(iii) The equation for the reaction was well known.

(iv) Most candidates correctly named this reaction as displacement, redox or an exothermic reaction.

(v) In the calculation of the concentration of the copper(II) sulfate, many candidates gained partial credit for correctly calculating the number of moles of iron that reacted but few went further to correctly calculate the concentration.

(d) Other observations that can be made are either a red/brown deposit of copper is seen or the blue colour of the solution fades or disappears. Surprisingly, only minority of candidates received credit here.

CHEMISTRY

Paper 5070/42
Alternative to Practical

Key messages

- Candidates should be advised to read the question carefully before answering.
- Candidates should be advised to attempt each question as credit cannot be given for blank answers.
- The number of marks shown and the amount of space provided give a guide to the length of answer required, and candidates who exceed the space provided may be wasting time giving unnecessary or irrelevant detail. It is helpful if candidates confine their answers to the space provided; if their answer continues elsewhere on the paper this should be made clear.

General Comments

The Alternative to Practical Chemistry paper is designed to test the candidate's knowledge and experience of practical chemistry.

Skills including recognition and calibration of chemical apparatus and their uses, recall of experimental procedures, handling and interpretation of data, drawing of graphs, analysis of unknown salts and calculations are examined.

The standard continues to be maintained and the majority of candidates show evidence of possessing many of the aforementioned skills.

Most candidates show competency of plotting points accurately on graphs and joining the points as instructed.

Calculations are generally completed successfully using the appropriate number of significant figures.

Comments on Specific Questions

Question 1

(a)(b) Apparatus **B**, a pipette, is used for measuring out a fixed volume of liquid in a titration.

Question 2

(a)

(i) The method of collection suggests that ethene is insoluble in water.

(ii) Candidates may suggest that aluminium oxide is used as a catalyst or to increase the speed of the reaction.

(iii) The structure of ethene should show all the bonds in the molecule.

(b)

(i)(ii) On passing ethene into aqueous bromine the colour changes from yellow or brown to colourless.

(iii) This reaction is an example of an addition or a saturation reaction.

(c)

(i) The alkene shown is butene.

(ii) Possible isomers include but-1-ene, methyl propene and cyclobutane. Many candidates were able to suggest one of these isomers and draw a correct structure.

Question 3

(a) Candidates should suggest that sea water has the higher boiling point because it contains dissolved salts. A suggestion that sea water is a mixture is not acceptable.

(b) The formula of the salt present in sea water is $NaCl$. The name alone cannot be awarded credit.

(c)

(i) Candidates were asked to draw a diagram of the apparatus used for distilling sea water into pure water. Credit was available for each correctly drawn part of the apparatus. It was good to see that most candidates were able to draw parts if not all of a suitable diagram. Common errors included a condenser with no inner tube, water circulating in the wrong direction, the apparatus completely closed and the top of reaction flask open.

(ii) Desalination and reversed osmosis are acceptable answers.

(d) Filtration or sedimentation are acceptable answers.

(e) Chlorine removes bacteria and is tested with litmus paper which is bleached on exposure to chlorine. Many candidates suggested that blue litmus turns red or vice versa and then turns white. Several candidates gave the test for chloride ions which was not appropriate.

Question 4

(a) Apparatus **D** is a syringe.

(b) Carbon dioxide when bubbled through lime water gives a white precipitate.

(c) A common error was to use two moles of sodium hydrogen carbonate, i.e. total molar mass 168, rather than 84, in calculating the mass that decomposes. This was a generally well answered question by a large number of candidates.

Questions 5 to 9

Correct answers to the multiple choice questions are **(d), (d), (c), (b)** and **(c)** respectively.

Question 10

(a) The correct colour change is yellow to blue. Although candidates may not have used this indicator the colours at the appropriate pH values were given in the stem of the question. This should enable candidates to deduce the correct colour change.

(b) The three titres were 26.1, 25.2 and 25.4 cm^3. The mean titre of 25.3 cm^3 is taken from the second and third titres. This titre is then used in the subsequent calculations. In the event of incorrect titres candidates should choose the two titres which are closest in value and indicate their choices by placing ticks in the boxes.

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

Question 11

(a) A colourless solution is produced. Candidates should always refer to the solution not a compound.

(b) A white precipitate soluble in excess.

(c) A white precipitate insoluble in excess.

(d) The test for a nitrate involves warming the compound with a mixture of aqueous sodium hydroxide and powdered aluminium. Ammonia or a gas which turns litmus blue is evolved. The use of nitric acid or a nitrate in the testing mixture means that credit cannot be awarded. The use of the 'brown ring test' is acceptable. The correct formula for aluminium nitrate is $Al(NO_3)_3$.

Question 12

This is the final question on the paper and tests the candidate's ability in the drawing and interpretation of graphs. Most candidates were able to plot the points accurately and draw smooth curves through the points, although there were few cases in which the smooth curves did not always pass through all of the points.

(a)

(i)(ii) The correct temperatures, taken from the thermometer diagrams, are 26, 35, 47 and 60 ^{0}C. These should be plotted on the grid and a smooth curve drawn through the points.

(b)

(i) Again, candidates needed to accurately plot the points shown in the table and draw a smooth curve through the points.

(ii) The correct answer is 132 seconds.

(iii) To obtain the concentration of the sodium thiosulfate, candidates should take the time when the temperature is 30 ^{o}C (60 seconds) from the first graph and use this on the second graph to find the concentration (0.052 mol/dm^3).