CHEMISTRY

Paper 5070/11
Multiple Choice

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

General comments

Questions 29 and **35** were found to be easy. Candidates found **Questions 4**, **21**, **26**, **29**, **30** and **34** to be challenging. There was evidence of guessing on **Questions 12**, **16**, **21**, **26**, **31** and **40**.

Comments on specific questions.

Question 4

Most candidates did not use the first statement to eliminate **D**. This could also be because they also did not appreciate that two of the dyes have the same R_f in the chromatogram, rather than one of them not being visible.

Question 8

More candidates chose option **B** than the key. These candidates interpreted '…different elements...' as '…the same elements...'.

Question 11

More candidates chose option **C** than the key. Candidates did not use the knowledge from 8.2(b) of the syllabus, that halogens are diatomic and so selected a value half of the correct answer.

Question 12

There was evidence of guessing by some candidates. Option **A** was also a common incorrect answer for some candidates. These candidates had correctly discounted the volume of water but had not included the unreacted oxygen from the total volume.

Question 16

There was evidence of guessing in this question. This item requires knowledge of several parts of the syllabus and the ability to use and apply the term endothermic.

Question 21

There was evidence of guessing in this question. Option **C** was also a common incorrect answer for some candidates. These candidates had correctly deduced that statement 3 is correct, showing that they understood that the reaction does not go to completion. However, they did not apply this to statement 2.

Question 26

There was evidence of guessing in this question. Option **A** was also a common incorrect answer for some candidates. Syllabus statement 7.4(a) lists the three raw materials and statement 2.3(a) is used to identify each one as either element, mixture, or compound. Either candidates were not able to apply 2.3(a) to 7.4(a) and/or they could not recall 7.4(a). Knowledge of 7.4(a) is poor for many candidates.

Question 30

Options **A** and **B** were chosen by candidates who performed less well overall. This suggests they have correctly used the Periodic Table to deduce M is a (transition) metal. However, options **A** and **B** include the statement 'It conducts electricity', which is correct for metals, 9.1(a), but not indicative of transition metals, 8.3(a).

Question 31

There was evidence of guessing by some candidates. This suggests poor knowledge of 9.2(a)(i) of the syllabus.

Question 34

More candidates chose option **B** than the key. These candidates correctly identified oxygen formation, but not the consequent oxidation of the carbon electrode.

Question 40

There was evidence of guessing by some candidates, with option **B** chosen more than the key. In option **B**, candidates did not take the two C=O units into account.

CHEMISTRY

Paper 5070/12
Multiple Choice

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

General comments

Candidates found **Question 8** easy and **Questions 4**, **11**, **12**, **13**, **22**, **24**, **25**, **26**, **30**, **34**, **37** and **40** to be challenging.

There was evidence of guessing on **Question 7**.

Comments on specific questions

Question 4

More candidates chose options **A** and **B** than the key. These candidates did not correctly apply the knowledge in the syllabus from 1.2(e) and so had the melting point of impure X higher, rather than lower, than pure X.

Question 7

Options **B** and **D** had the highest temperatures and were selected by many candidates. These candidates may have correctly linked this to faster diffusion, but the question was in terms of length of time to diffuse, not rate of diffusion.

Question 11

More candidates chose option **C** than the key. Candidates did not use the knowledge from 8.2(b) of the syllabus that halogens are diatomic and so selected a value half of the correct answer.

Question 12

Candidates selecting option **D** chose the reaction with the largest volume of gaseous products rather than, as required, the largest percentage change.

Question 13

Option **C** was a common incorrect choice. Candidates calculated the volume of 0.0800 mols of CO_2. They did not then apply the stoichiometry between the reactants and deduce that the acid is the limiting reagent.

Question 22

Option **B** was chosen incorrectly by many candidates. This indicates a lack of knowledge on salt preparation knowledge from 7.2(a) of the syllabus.

Question 25

Some candidates selected option **A**. These candidates correctly linked increasing pressure with a higher percentage of ammonia at equilibrium. However, they incorrectly linked a higher temperature with a higher percentage of ammonia at equilibrium and did not consider the exothermic forward reaction.

Question 26

More candidates chose option **A** than the key. This item needed knowledge from 7.4(a), (b) and (c) of the syllabus. Knowledge of 7.4(a) was poor for candidates who performed less well overall.

Question 30

Options **A** and **B** were chosen by some candidates. This suggests they have correctly used the Periodic Table to deduce M is a (transition) metal. However, options **A** and **B** include the statement ‘It conducts electricity’, which is correct for metals, 9.1(a), but not indicative of transition metals, 8.3(a).

Question 34

More candidates chose option **B** than the key. These candidates correctly identified the production of oxygen, but not the consequent oxidation of the carbon electrode.

Question 37

More candidates chose option **B** than the key. These candidates incorrectly identified C_xH_y as a saturated hydrocarbon rather than the product, C_xH_{y+2}.

Question 40

There was evidence of guessing by some candidates, with option **B** being chosen more than the key. In option **B**, candidates did not take the two C=O units into account.

CHEMISTRY

Paper 5070/21
Theory

Key messages

- Candidates must use the correct terminology when explaining the physical properties of substances using ideas about structure and bonding. The structure is either giant or simple and the bonding is covalent, ionic, or metallic. It is also important that the type of bonding is not contradicted within the answer, for example reference to ions in a giant covalent structure.
- Candidates must not confuse ideas about chemical equilibria and rate of reaction. They should not use collision theory when answering questions about chemical equilibria.
- Candidates found some of the organic questions quite challenging and were not able to draw the correct structures of esters and polymers.

General comments

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

Candidates often showed sufficient working out in quantitative questions to be awarded error carried forward marks from earlier errors.

In ***Section B***, the **Question 9** was the least popular of the optional questions.

Comments on specific questions

Section A

Question 1

This question was about oxides. Candidates found all but **(a)** straight forward.

(a) Most candidates could not recognise the oxide, which had a simple molecular structure. The most common answer was silicon dioxide.

(b) Many candidates recognised that iron(II) oxide is a coloured solid.

(c) Many candidates recognised that aluminium oxide contains an ion with a 3+ charge.

(d) Many candidates recognised that calcium carbonate decomposes to make calcium oxide.

(e) Most candidates recognised that sulfur dioxide contributes to acid rain.

Question 2

This question was about gases found in air.

(a) A significant number of the candidates gave answers within the range 20 to 22 per cent but only 21 per cent was accepted.

(b) Many candidates found this question challenging. Candidates often did not appreciate that carbon dioxide was an acidic oxide and so would react with the alkaline solution of aqueous sodium hydroxide. Some candidates did appreciate that sodium carbonate or sodium hydrogencarbonate would be formed but often included incorrect gaseous products such as hydrogen and oxygen. A common misconception was that a displacement reaction occurs with sodium replacing carbon. Other candidates just referred to the carbon dioxide dissolving or being absorbed by the aqueous sodium hydroxide.

(c) Fractional distillation was well known but many answers did not refer to the use of liquid air even though they appreciated that the separation worked because the gases had different boiling points.

(d) The test for oxygen was well known. A small proportion of the candidates used a lighted splint rather than a glowing splint.

(e) (i) Some candidates recognised that it was a photochemical reaction, but a common misconception was to refer to a substitution reaction. Answers that referred to a redox reaction were also accepted. A small, but significant, proportion of the candidates did not attempt this question.

(ii) Candidates often gave vague answers such as from air or repeated answers that were similar to the information in the stem of the question. The most common correct answers were lightning and volcanoes. A small, but significant, proportion of the candidates did not attempt this question.

(f) Skin cancer was quite well known but candidates rarely referred to sunburn. Answers sometimes referred to stopping ultraviolet reaching the Earth's surface but did not mention that more of the harmful ultraviolet radiation would reach the Earth's surface.

Question 3

This question was about the reaction between iron and dilute sulfuric acid.

(a) (i) Most candidates could interpret the graph to state that it takes 6 minutes to make 18 cm^3 of hydrogen gas.

(ii) Candidates were often able to draw a line on the graph that had a greater initial gradient because the reaction was faster. Only a small proportion of candidates gave a volume that was greater than 34 cm^3. Some candidates did not take sufficient care with their line and did not start at the origin.

(b) (i) The idea that particles were gaining kinetic energy or moving faster was well expressed, but many of the answers focused on the frequency of collisions rather than more successful collisions. Hardly any candidates mentioned activation energy in their answers. The question had two command words, describe and explain, and some candidates forgot to mention that the rate of reaction increased.

(ii) The link between larger pieces of iron and a smaller surface area was poorly understood by many candidates. The best answers appreciated that there was less surface available for particles to collide and as a result the collision frequency also decreased. As in **(i)**, some candidates only gave an explanation and did not describe how the rate of reaction changed.

(c) A significant proportion of the candidates quoted the correct answer of 1.68 dm^3. Candidates that calculated the incorrect number of moles were often able to use the molar volume of a gas correctly but did not always get an error carried forward mark because they quoted the answer to more than three significant figures.

(d) The test for an oxidising agent was not well known. Many candidates gave the test for a reducing agent, typically giving acidified potassium manganate(VII). Other candidates tested for acidity using indicators. If the correct test was described, the candidates also gave the correct observations.

Question 4

This question was about alkenes.

(a) Candidates were not able to give a precise definition of the term cracking. Many candidates just mentioned large molecules being made into smaller molecules but did not mention the nature of the molecules. The best answers described cracking as the action of heat on large alkanes to make smaller alkanes, akenes and hydrogen.

(b) (i) Hydrogen was well known.

(ii) Many candidates recognised that the reaction was addition or hydrogenation. Some candidates referred to reduction, which was also given credit.

(c) Candidates found this question challenging and often gave an incorrect formula for ethanol. Equations involving molecular formulae or structural formulae were both allowed. If a candidate wrote two equations, one with a molecular formula and the other with structures, both had to be correct.

(d) The empirical formula calculation was quite well done by the candidates. Almost all candidates showed the full working out. The most common misconceptions were to invert the expression for amount in moles or using the atomic number rather than the relative atomic mass.

Question 5

This question was about the reaction between magnesium and aqueous silver nitrate.

(a) Many candidates referred to magnesium losing electrons. Other candidates stated that the oxidation number increased. Answers that just referred to the charge of magnesium increasing were not given credit.

(b) A small proportion of the candidates drew incorrect diagrams or left the question blank. Candidates were more likely to get the relative positions of the reactants and products correct than the labelling of the enthalpy change. Candidates often had double headed arrows and did not indicate the direction of the arrow, for example by indicating that ΔH was negative. Other candidates had the activation energy labelled as the enthalpy change or the line went to the *x*-axis rather than the product line.

(c) Some candidates recognised the presence of the iodide ion.

(d) Candidates found this question challenging. Candidates rarely mentioned layers of positive ions or layers of atoms and just referred to layers sliding over each other. Other candidates did not mention layers at all and just referred to atoms or ions sliding over each other.

(e) Candidates found expressing their answers very challenging and did not seem to understand the term ease of thermal decomposition. The best answers referred to the decomposition temperatures rather than the ease of decomposition, for example, 'as the metal in the carbonate gets less reactive the decomposition temperature decreases'. A common misconception was to refer to boiling point or melting point rather than decomposition temperature.

Question 6

This question was about the reaction of phosphorus to form phosphorus(III) chloride.

(a) The best answers described bond breaking as endothermic, bond making as exothermic and then compared the amount of energy released with that absorbed. The most common misconception was that the reaction was exothermic since it only involved bond making.

(b) (i) Candidates often gave the correct products. There were some examples of iodine chloride or chlorine iodide and potassium being the products.

(ii) A significant proportion of the candidates made the correct comparison between the reactivity of bromine and the reactivity of chlorine. Other candidates compared bromine with chloride or bromine with potassium.

(c) Candidates found constructing the equation quite challenging because they were unable to write the formula for phosphorus(III) chloride. Common incorrect formulae included P_3Cl, PCl, $POCl_3$ and PCl_2.

Section B

Question 7

This question was about metals and metal compounds and was the most popular of all the optional questions.

(a) Many candidates were able to give two differences in the physical properties of silver and potassium. The most common answers compared hardness, melting point and boiling point. Common misconceptions included physical properties that were similar for both metals e.g., malleability and ductility.

(b) Candidates often got at least two of the numbers correct. They were most likely to get the number of electrons in the silver ion incorrect with 47 and 48 being common answers.

(c) Candidates were often able to complete the equation. Some candidates gave oxygen as the gaseous product rather than using the chemical test to identify hydrogen.

(d) (i) Some candidates recognised that the position of equilibrium moves to the left but other candidates contradicted their answer by stating that more product was formed. Candidates found it difficult to express their explanation and only the best answers stated it was because the backward reaction was exothermic.

(ii) Some candidates recognised that the position of equilibrium moves to the left but generally explained this statement by reference to rate of reaction rather than minimising the increase in carbon dioxide concentration by reaction with zinc oxide.

Question 8

This question was about an unsaturated compound called angelic acid. Candidates found this question challenging.

(a) Candidates often recognised that the carbon-carbon double bond in the molecule made angelic acid unsaturated. A small proportion of the candidates were imprecise and only mentioned the presence of a double bond and this was not given credit.

(b) Candidates found this question very challenging. Many candidates did not have the correct number of each atom and/or did not write a molecular formula but included some structure e.g. C_4H_7COOH.

(c) (i) The definition of an acid was well known with candidates referring to the presence of a hydrogen ion, proton, or hydroxonium ion. Only a small proportion of the candidates defined an acid in terms of their effect on indicators or in terms of pH.

(ii) Most candidates were able to explain the meaning of weak as applied to acids. The most common misconception was to refer to dissolve rather than dissociate.

(d) (i) Many candidates recognised that addition polymerisation occurs. Candidates who referred to additional polymerisation were not given credit.

(ii) Although some candidates were able to draw the partial structure of the polymer many drew incorrect structures. Including the double bond was a common error, as was omission of extension bonds at either end of the structure and including incorrect side chains. A significant proportion of the candidates did not attempt this question.

(e) Candidates found this question very challenging and either left it blank or just added a H or –OH to the structure. The structure of the ester functional group was rarely written correctly.

(f) The formulae for the products of the reaction were well known but often candidates wrote down the incorrect formula for methanol or missed out oxygen as a reactant. Most correct equations used integers to balance the equation rather than fractions.

Question 9

This question was about ammonia and nitrates. This was the least popular of the optional questions.

(a) Candidates were more likely to give the source of nitrogen than the source of hydrogen. Water and hydrocarbons were the most common source of hydrogen. A common misconception was that hydrogen comes from air.

(b) Some candidates were able to present a coherent argument to show that the ammonium sulfate was in excess. Candidates normally used approaches based on moles and mole ratios for example calculating:

- the number of moles of NaOH in 4.50 g
- the number of moles of ammonium sulfate that reacts with the 4.50 g of NaOH
- the number of moles in 50.0 cm^3 of a 1.25 mol / dm^3 solution.

The most common misconceptions were to use 80 for the relative formula mass of NaOH and to use mass for ammonium sulfate. A small proportion of the candidates did not attempt this question.

(c) Most candidates were unable to construct the correct ionic equation. Typically, electrons were either not shown or on the wrong side of the equation. Other candidates did not attempt the question.

(d) Only a small proportion of the candidates identified the type of reaction as reduction. Common incorrect answers included displacement, precipitation and neutralisation.

(e) Most candidates did not include important details in the process of eutrophication such as the increased growth of algae and that the bacteria that decay dead plants use up oxygen. A common misconception was that the algal bloom prevented oxygen entering the water. Another misconception was that the nitrates poisoned the aquatic animals.

Question 10

This question was about metals and metal compounds.

(a) (i) Most candidates were able to predict the density of tin.

(ii) Candidates were able to interpret the table to state that the boiling point decreases down the group. Some candidates just stated that it decreases, and this was not given credit since it did not state if the trend was up or down the group.

(iii) Candidates were often able to identify silicon as a liquid at 1600 °C; they were not always able to give a reason for the answer. The best answers appreciated that 1600 °C was above the melting point but below the boiling point. A significant proportion of the candidates only mentioned the melting point or the boiling point, but not both.

(b) (i) Many candidates found this question very challenging and often did not use the correct chemical terminology. Although candidates often recognised that **P** had a giant covalent structure, a common misconception was then to refer to strong intermolecular forces rather than strong covalent bonds between atoms. Candidates often recognised **Q** as a molecule and then referred to the presence of weak intermolecular forces. However, many of the answers contradicted correct ideas by referring to weak bonds between atoms rather than between molecules. Candidates did not often refer to the correct structure, simple molecular or simple covalent, instead they often used molecular or covalent and missed out the reference to simple.

(ii) A significant proportion of the candidates drew the correct dot-and-cross diagram for $SiCl_4$. There were very few answers that showed ionic bonding. The most common mistake was to forget to include the non-bonding electrons in the valence shell of chlorine.

(c) Candidates were often able to calculate the percentage of carbon as 54.5 per cent. The most common mistake was to calculate the correct relative formula mass but only use one carbon atom rather than four when calculating the percentage.

CHEMISTRY

Paper 5070/22
Theory

Key messages

- Some candidates would benefit by improving their knowledge of specific chemical terms.
- Many candidates need more practice in writing with precision.
- Some candidates need more practice in interpreting the stem of a question.
- Many candidates would benefit from a deeper revision of organic chemistry.

General comments

Many candidates tackled this paper well, showing a good knowledge of general Chemistry. The standard of English was generally good. A significant number questions were left unanswered by some candidates.

Some candidates need more practice in learning specific chemical terms and chemical nomenclature. For example, in **Question 2(a)** the meaning of incomplete combustion was not well known, whilst in **Question 2(c)** the term natural resources was not always well known. In **Question 4(a)(ii**), many candidates muddled the terms general formula and molecular formula. Some candidates would benefit by learning more about basic chemical nomenclature. In various parts of the paper, candidates muddled the suffixes -ide, -ine and -ate. In **Question 10(b)(i)**, a majority of the candidates did not appear to understand basic terms about structure and bonding and muddled the terms ion, atoms and molecules. Others did not distinguish between physical and chemical properties (**Questions 4(a)** and **6(a)**).

Some candidates could improve their performance by writing with greater specificity. Others need more practice in writing answers with the correct amount of detail and precision, using specific chemical terms. For example, in **Question 2(d)** many candidates wrote vaguely about 'pollution' or 'dangerous', whilst in **Question 2(e)** many candidates did not refer to named gases. In **Question 3(b)(i)**, some candidates wrote vague statements relating to particles colliding without mentioning the essential word 'frequency'. In **Question 3(b)(i)**, many candidates wrote about energy decreases without the essential word 'kinetic' or did not refer to 'effective collisions'. In **Questions 3(d)** and **8(c)**, many candidates did not write the name of the oxidising agent precisely enough e.g. 'potassium manganate(IV)'. Candidates should be advised to name accurately the particular chemicals which appear in the in the syllabus. In **Question 5(a)**, many candidates did not gain credit because they wrote about zinc (which is on the right of the equation) gaining electrons rather than zinc ions (on the left of the equation) gaining electrons. In **Question 5(c)(ii)**, some candidates did not gain credit because their answers were too vague. The statement 'chlorine is more reactive' is insufficient on its own. In **Question 6(a)**, many candidates did not gain credit for the enthalpy change because they drew a double headed arrow or no arrow at all, instead of a single-headed upward arrow. Many candidates wrote conflicting statements when explaining why the formation of phosphine form phosphorus and hydrogen is endothermic in **Question 6(b)**. In **Question 10(b)**, some candidates wrote vaguely about free electrons rather than moving electrons.

Many candidates need more practice in interpreting the stem of a question. For example, in **Question 2(c)**, many candidates gave answers about waste gases from animals or natural gas which were examples given in the stem of the question. A similar problem arose in **Question 4(a)(i)** where some candidates gave answers which were already in the stem of the question. In the same question some candidates gave chemical properties rather than physical properties. In **Questions 3(b)(i)** and **3(b)(ii)**, some candidates did not heed the command word 'describe' and therefore did not write down how the rate of reaction was affected by the change in conditions. Candidates should be advised to learn the meaning of the command words listed in the syllabus.

Some candidates would benefit from further revision of specific topic areas such as organic chemistry (**Questions 4(a)** to **(c)** and **8(a)** to **(g)**), especially polymers and esters. Other areas in which candidates would benefit from further revision are chemical tests (**Questions 5(b)** and **8(b)** and **8(c)**), and structure and bonding (**Questions 8(d)**, **8(e)** and **10(b)(i)**).

Many candidates were able to undertake chemical calculations involving the use of moles and gas volumes, percentage yield and calculation of empirical formula. Others need more practice in these areas.

Comments on specific questions

Section A

Question 1

This was the best answered of the ***Section A*** questions with many candidates identifying at least three of the compounds correctly. Parts **(b)** and **(d)** were the best answered.

(a) Many candidates recognised cobalt(II) chloride. The commonest error was to suggest aluminium chloride. A few selected potassium chloride, sodium chloride or silver chloride. Nearly all those candidates who wrote oxidation numbers correctly in other questions e.g. **Question 8(c)** and **Question 9(a)(ii)** gained credit for this question by equating the Roman numeral (II) with the charge on the ion.

(b) A majority of the candidates recognised that iron(III) chloride forms a red-brown precipitate on addition of sodium hydroxide. The commonest error was to suggest ammonium chloride. Silver chloride or cobalt chloride were other incorrect responses, which were not infrequently seen.

(c) Many candidates recognised that silver chloride is insoluble in water. A wide variety of incorrect answers were seen, sodium chloride or ammonium chloride being the commonest.

(d) The majority of candidates recognised that ammonia is formed when sodium hydroxide is warmed with ammonium chloride. A significant number of candidates chose the wrong gas and gave hydrogen chloride.

(e) Many candidates recognised that hydrogen chloride is an acidic gas. The commonest incorrect answers were ammonium chloride, aluminium chloride or iron(III) chloride. Whilst these compounds will hydrolyse to form acidic solutions, a pH of 1 will never be obtained.

Question 2

Many candidates gave good answers to **(b)** (test for carbon dioxide) and **(d)** (effect of methane in the atmosphere). In **(a)**, many did not realise the difference between incomplete combustion and complete combustion, whilst in **(c)**, few knew a natural source of methane. In **(e)**, many candidates gave answers which were too vague to be awarded any credit.

(a) Better performing candidates recognised that incomplete combustion produced carbon monoxide and that the octane in the fuel could be also found in the exhaust gases. Many candidates gave the products of complete combustion: carbon dioxide and water. Water was not accepted as an answer because it is present in both complete and incomplete combustion. The commonest error was to suggest nitrogen dioxide.

(b) The majority of candidates gave the correct test for carbon dioxide using limewater. The commonest error was to suggest using a glowing or lighted splint. A minority of candidates suggested reaction with sodium hydroxide or silver nitrate.

(c) The best answers referred to the decomposition or decay of vegetation. Many candidates did not read the stem of the question properly and gave the examples that were stated in the question (natural gas and waste gases from animals). Many referred to cows or 'from animals' or were not specific enough in their answers by missing out the essential words 'decomposition' or 'decay' when referring to plants. Others suggested 'burning plants' or the unqualified 'dead plants' or 'dead animals'.

(d) Many candidates chose the correct words 'greenhouse' and 'global warming'. The commonest errors occurred in the first marking point, where the commonest incorrect answers were 'poisonous', harmful', 'polluting' or 'dangerous'.

(e) The best answers referred to both carbon monoxide and nitrogen dioxide as being formed in the exhaust gases and gave the products formed as a result of the reactions in the catalytic converter. Some candidates gave descriptions of the catalysts and exhaust gases passing through with no reference to specific gases. Others described the process of catalysis and how catalysts work in general rather than giving the names of the gases formed. Some candidates realised that carbon monoxide is formed in the engine but did not mention oxides of nitrogen.

Question 3

Some candidates answered the questions about rate of reaction well. Others wrote statements which were too vague when answering **(b)(i)** and **(b)(ii)**. Part **(a)** was the best answered part of the question with most candidates gaining some credit. In **(c)**, many candidates calculated the moles of magnesium correctly but fewer were able to take the calculation further. Part **(d)** (test for a reducing agent) was the least well answered part of this question with many candidates appearing to guess the reagent and test result.

(a) The majority of candidates drew, correctly, an initial gradient which was shallower. Fewer gained credit for the final level being lower than the line with the higher concentration.

(b) (i) Few candidates gave convincing answers in terms of collisions between particles. Many forgot to state what happened to the rate of reaction. Responses often stated that the magnesium powder has a larger surface area. A considerable number of candidates wrote answers in terms of the particles of magnesium being closer together rather than more particles being exposed on the surface. Few candidates gained credit for increase collision frequency. The commonest errors here were unqualified statements such as 'more collisions', 'more chances of collisions' or 'more effective collisions'.

(ii) Few candidates gave convincing answers in terms of number of effective collisions. Many forgot to state what happened to the rate of reaction. The best answers referred to lower kinetic energy and decreased numbers of effective collisions. Many either omitted the word 'kinetic' or gave a conflicting answer such as 'it <u>gains</u> less kinetic energy'. Another common error was to state that there was a decreased frequency of collisions' rather than referring to the effectiveness of the collisions. A considerable number of candidates answering in terms of activation energy did not gain credit because they suggested that the activation energy was decreased.

(c) Many candidates calculated the number of moles of magnesium correctly but did not take the calculation further or multiplied by 12 or 2 rather than 24. A significant number of candidates divided by 24 to get the volume of gas rather than multiplying by 24.

(d) Few candidates knew a suitable test for a reducing agent. Most seemed to guess a test reagent e.g. 'sodium hydroxide', 'magnesium', 'iodine'. A significant number of candidates muddled the test for reducing agents with the test for oxidising agents and suggested 'potassium iodide'. The colour change was often the incorrect way round i.e. 'colourless to purple'. A few candidates gained credit by suggesting potassium dichromate, with the correct colour change. A significant number of candidates did not respond to this question.

Question 4

Some candidates exhibited a good grasp of organic chemistry. Others need more practice in this topic area. Part **c(i)** (conditions needed for cracking) was the best answered part. In **(a)(i)**, very few candidates were able to recognise viscosity as the physical property which increases as the number of carbon atoms in the chain increases. Parts **(a)(ii)**, **(b)**, and **(c)(ii)** were well answered by the overall better performing candidates. Others tended to omit or guess the answers. In **(d)**, many candidates knew the initial step in the calculation of the empirical formula but rounded the figures for the ratio of carbon to hydrogen to give CH_2 rather than C_2H_3.

(a) (i) Very few candidates were able to recognise viscosity as the physical property which increases as the number of carbon atoms in the chain increases. The commonest incorrect answer was flammability. Other common incorrect answers included mass, melting point, boiling point and density. The last three were given in the stem of the question. Candidates could improve their performance by reading the stem of the question carefully. Many candidates did not gain credit because they gave chemical properties rather than physical properties.

(ii) The best answers referred to 'similar chemical properties' and 'same functional group'. Many candidates gave answers relating to conduction, density, melting point and boiling point. Others muddled general formula with molecular formula or structural formula or suggested 'the functional groups are different' or 'they have a functional group' rather than 'the same functional group'.

(b) A minority of the candidates understood that the reaction was a substitution reaction and gave a suitable reactant. The commonest incorrect answer was 'addition'. Many candidates appeared to guess the answer e.g. 'fermentation' 'combustion', 'polymerisation'. The commonest incorrect answer for the reactant was 'hydrogen chloride. Those who wrote fermentation as a reaction type often gave water as a reactant. Those who wrote addition often gave hydrogen or hydrogen chloride as an answer and those who wrote polymerisation often suggested monomers as a reactant. A significant number of candidates did not respond to this question.

(c) (i) This was the best answered part of **Question 4**. The best answers included 'catalyst' and 'high temperature'. Some candidates who only gave values for the temperatures or pressures did not gain credit because the values were out of the range accepted. These values were often too low in terms of temperature or too high in terms of pressure.

(ii) Some candidates were able to write a balanced equation. The commonest errors were to give the formula for the alkene as C_4H_{10} and/or the formula of the alkane as C_8H_{20}.

(d) Many candidates knew the initial step in the calculation of the empirical formula but rounded the figures for the ratio of carbon to hydrogen to give CH_2 rather than C_2H_3.

Question 5

This was the least well answered question of ***Section A***. Few candidates were able to explain the equation in **(a)** in terms of redox, whilst in **(b)** a wide variety of incorrect observation were given. In **(c)(ii)**, only a minority of the candidates could explain why aqueous bromine does not react with aqueous zinc chloride. In **(c)(i)**, many candidates muddled the suffixes -ide and -ine.

(a) A minority of the candidates gained full credit, the commonest error being to write about zinc (which is on the right of the equation) gaining electrons rather than zinc ions (on the left of the equation) gaining electrons. Those who did gain credit often did so for the idea that oxidation is a loss of electrons and reduction is a gain of electrons.

(b) Few candidates realised that aqueous iodides form yellow precipitates when added to aqueous silver nitrate. A common incorrect answer was 'white precipitate'. The word precipitate was sometimes omitted, or another incorrect colour was given, green or orange being not uncommon incorrect answers. Many candidates wrote about bubbles being formed or gave vague statements about solubility.

(c) (i) Many candidates muddled the suffixes and wrote zinc bromine instead of zinc bromide or iodide instead of iodine. A significant number of candidates suggested bromine iodide or iodine bromide.

(ii) Many candidates did not gain credit because their answers were too vague. The statement 'chlorine is more reactive' is insufficient on its own. Candidates should be encouraged to make clear what the reactivity is being compared with. Many candidates made the incorrect comparisons e.g. 'chlorine is more reactive than zinc' or 'chlorine is more reactive than bromide'. Many candidates reversed the reactivity i.e. 'bromine is more reactive than chlorine' or discussed the relative positions of chlorine and bromine in Group VII without referring to reactivity.

Question 6

Some candidates were able to draw a correct energy profile diagram in **(a)**. Others put the reactants, products or enthalpy change in the incorrect positions. In **(b)**, many candidates did not gain credit because they either muddled the type of energy change in bond making and bond breaking or wrote conflicting statements about the energy changes. The equation in **(c)** was correctly completed by the majority of candidates.

(a) Many candidates drew the reactants and products on the horizontal lines, but a significant number drew them on the upward curve and had no starting or ending level. Others drew a diagram for an exothermic reaction. The position of the arrow for ΔH was often incorrect, many candidates mistook enthalpy change for activation energy. Others showed a double headed arrow or no arrow at all. These candidates did not gain credit because the sign of the enthalpy change was not written. Candidates should also be advised to make the arrows representing the enthalpy change the correct length, not too long and too short.

(b) The best answered referred to bond breaking as endothermic and bond making as exothermic with some indication that more energy was absorbed than released. Many candidates wrote conflicting statements often implying that energy is needed to break and form bonds. Others only discussed breaking bonds being endothermic. Without any reference to making bonds or energy released, these candidates could not gain credit.

(c) The majority of candidates balanced the equation correctly.

Section B

Question 7

This was the best answered question of ***Section B***. Most candidates were able to deduce the number of sub-atomic particles in **(b)** and many were able to state the differences between sodium and diamond in **(a)** and to balance the equation in **(c)**. Fewer candidates gained credit for the equilibrium questions in **(d)**.

(a) Many candidates stated the differences in the physical properties of sodium and diamond. Many candidates wrote about the structure or chemical properties rather than physical properties. Other common errors included: sodium having high melting point (or boiling point), sodium being hard, sodium being transparent or the opposite for diamond. Some candidates wrote statements about the same point twice e.g., 'sodium is soft' on line 1 and 'diamond is hard' on line 2.

(b) Many candidates performed well on this part. The commonest error was to ignore the charge on the sodium ion and suggest 11 electrons or (less commonly) 12 electrons. A few candidates muddled the particles and suggested 10 protons or 23 neutrons.

(c) Many candidates balanced the equation correctly. The commonest error was to write 2N instead of N_2.

(d) (i) Many candidates gave the correct direction for the equilibrium shift. The commonest error was to suggest that the equilibrium shifts to the left. Only a few suggested that there is no change. Most candidates who suggested that the equilibrium shifts to the right gained credit for a statement that the forward reaction is endothermic.

(ii) The best answers referred to equilibrium shifting to the right because there are more moles of gas on the right than on the left. Most candidates suggested that there was no change to the equilibrium. Many candidates just referred to equal numbers of moles on each side of the equation. Candidates should be advised to look carefully at the state symbols in the equation to ascertain the relative number of moles of <u>gas</u> on each side of the equation.

Question 8

These was the least well-done question of ***Section B***. Many candidates need to revise aspects of organic chemistry, especially carboxylic acids and polymerisation. The majority of candidates recognised the ions present in all acids in **(f)(i)**. Hardly any candidates knew the colour change when an excess of an unsaturated compound is added to aqueous bromine.

(a) A minority of the candidates wrote the correct molecular formula for compound **T**. The commonest errors being C_3H_5OH or CH_2CHCH_2OH. Others made simple errors in counting the atoms e.g. C_3H_7O.

(b) Few candidates gave the correct colour change. Those giving the correct colours, usually did not realised that the unsaturated compound was being added to the bromide rather than the other way around and so gave the incorrect answer 'colourless to orange'. The colour of the bromine was often suggested to be brown or red-brown, which would be suitable for liquid bromine but not for aqueous bromine. A significant number of candidates chose other colours such a blue or red.

(c) The best answers gave the correct oxidation number for potassium permanganate i.e. potassium manganate(VII). Many candidates gave incorrect oxidation numbers, sometimes referring to the potassium rather manganese.

(d) The best responses showed a structure containing a chain of four single-bonded carbon atoms with extension bonds and with the correct side chains. Common errors included the presence of double bonds in the carbon chain, missing extension bonds and/or oxygen atoms (or hydrogen atoms) in the carbon chain. A significant number of candidates did not respond to this question.

(e) Few candidates were able to complete the structure of the ester correctly. Many candidates who had some knowledge of the structure of esters wrote the COO group the wrong way round. Other common errors included hydrogen atoms in the middle of a chain or alcohol or carboxylic acid groups. Many candidates drew structure which bore no relationship with esters e.g. hydrocarbon groups.

(f) (i) Most candidates recognised the H^+ ion as being responsible for acidity. A common error was to write the general or specific formula of various alkanes or alkenes. A few suggested the OH^- ion.

(ii) The best responses realised that methanoic acid has a lower concentration of hydrogen ions than hydrochloric acid or related the rate of reaction to degree of ionisation. Many did not go far enough and just stated that methanoic acid is a weak acid and hydrochloric acid is a strong acid or that hydrochloric acid is more reactive.

(g) A minority of the candidates gained full credit. The formula for magnesium ethanoate was often incorrect; common errors were MgCOOH or MgCOO. Many candidates did not appreciate the structure of an ester and wrote the formula of magnesium oxide or magnesium hydroxide. Others did not recognise the pattern of acid + metal → salt + hydrogen and suggested that carbon dioxide or water is formed. Some candidates who got the formula of the salt correct did not balance the equation or omitted the hydrogen. A significant number of candidates did not respond to this question.

Question 9

Few candidates answered each part of this question well. Candidates performed best in **(b)(i)** (definition of electrolysis) and **(d)** (reaction of sodium hydroxide with ammonium sulfate). In **(a)(i)**, hardly any candidates identified the raw materials used to make sulfuric acid, whilst in **(a)(ii)**, many candidates wrote answers which were not specific enough. In **(b)(ii)**, a minority of the candidates wrote the correct ionic equation. The final stage of the calculation in **(c)** was not always demonstrated with clarity.

(a) (i) Few candidates seemed to understand the term 'raw materials'. Most gave 'oxygen' rather than 'air' and 'sulfur dioxide', 'sulfuric acid' or hydrogen instead of water. Many suggested 'sulfur' despite this element being in the stem of the question.

(ii) Some candidates wrote the full name of the catalyst as vanadium(V) oxide but many did not include the oxidation number or gave the incorrect oxidation number. Common errors included 'iron', 'vanadium' 'aluminium oxide' or 'hydrochloric acid'. A significant number of candidates did not respond to this question.

(b) (i) Many candidates gave a reasonable definition of the term electrolysis. Common errors included 'breakdown of a substance', 'breakdown of an element' or 'separation of elements'. Most candidates obtained credit for the idea that an input of electricity is needed.

(ii) A minority of the candidates wrote the correct ionic equation. Many wrote the equation for the formation of oxygen rather than the formation of hydrogen. The commonest errors were to write H or H_2^+ instead of $2H^+$, the inclusion of sulfate ions or sulfuric acid on the left-hand side of the equation, addition of electrons on the right-hand side of the equation or the omission of electrons altogether. A significant number of candidates did not respond to this question.

(c) Many candidates calculated the moles of sodium hydroxide correctly. Fewer calculated the moles of sulfuric acid correctly. Few candidates gave convincing explanations to show that the sodium hydroxide is in excess. Many candidates appeared to guess how to explain the final stage by using the numbers in the question alone without explaining what they meant e.g. $(0.2 \div 76) \times 45$. A significant number of candidates did not respond to this question.

(d) Many candidates identified at least two of the three products correctly. Common errors included 'ammonium hydroxide' (rather than ammonia), 'hydrogen', 'sulfur', 'sodium oxide' or 'carbon dioxide'.

Question 10

Many candidates predicted the density of antimony in **(a)(i)** and gave a correct reason why it is difficult to predict the melting point of arsenic in **(a)(ii)**. The majority of candidates were able to draw the dot-and-cross diagram correctly in **(b)(iii)** and calculate the percentage by mass in **(c)** correctly. Fewer gave convincing answers to the structure and bonding question in **(b)(i)**.

(a) (i) Most candidates predicted a correct value for the density of antimony.

(ii) Many candidates gave correct answers such as 'there is no pattern' or 'there is no trend in the values'. Others just stated that the trend was irregular or tried to give explanation for a purported trend. Other incorrect answers included, 'melting point is high', 'it is a gas' or answers trying to relate density to melting point.

(b) (i) Many candidates did not gain credit because they confused ionic and covalent bonding. Many answers about ionic structure and bonding were negated by statements about intermolecular forces. Others mentioned giant structures but not ions or mentioned ions without the idea of a lattice. Some candidates thought that the particles in an ionic structure are atoms. Candidates who performed well recognised that structure **S** is a molecule and mentioned intermolecular forces. Others wrote incorrectly of weak forces between the atoms or ions.

(ii) A minority of candidates recognised that structure **R** conducts electricity because the ions move when **R** is molten. Candidates should be advised that the idea of the ions being free is not sufficient to explain electrical conduction. There must be some reference to mobile or moving ions. Most candidates thought, incorrectly, that it was the electrons which were responsible for the conduction.

(iii) Many candidates drew the dot-and-cross diagram correctly. Common errors were to miss out the non-bonding electrons or to add extra electrons to the hydrogen atoms. A minority of candidates drew ionic structures or just drew the electronic structure of phosphorus.

(c) The majority of candidates calculated the percentage by mass of phosphorus correctly. Common errors were to use 124 or 31 as the numerator, invert the division of mass of phosphorus by the molar mass of P_4O_{10}, or to attempt an empirical formula calculation.

CHEMISTRY

Paper 5070/31
Practical Test

Key messages

- Success in this paper required a candidate to meet the practical and mathematical demands of a volumetric exercise.
- Candidates competent in following instructions involving test-tube reactions and in the accurate recording of their observations performed well.

General comments

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

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

The number of scripts received in this series was extremely small and therefore a narrower range of different responses was seen than normal.

Comments on specific questions

Question 1

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

The majority of candidates attempted all the calculations that followed, and many performed well.

(b) This was calculated correctly by most, although some candidates overlooked the instruction to give an answer to three significant figures.

(c) The majority divided their answer to **(b)** by two correctly, although some did not realise that they needed to apply the stoichiometry shown by the equation. Multiplication by two was also seen.

(d) Many candidates were able to multiply the answer from **(c)** by 200 ÷ 25.

(e) This was often correctly tackled. Even if the number of moles of sodium carbonate was incorrectly calculated in **(d)**, candidates were able to gain credit both for the correct M_r and an error carried forward.

(f) This was answered correctly by only the better performing candidates. Those who incorrectly produced an unfeasibly large mass in **(e)** recognised that the mass in this question should be a positive number and achieved this by calculating **(e)** – 13.73 g instead of 13.73 g – **(e)**, for which no credit was available.

(g) Candidates often recovered from accumulated errors earlier by correctly dividing **(f)** by 18 for an error carried forward.

(h) This challenging final part was sometimes not attempted and relatively few were able to produce a valid ratio.

Question 2

Nearly all the marking points were awarded in the assessment of the examination scripts.

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

(a) (i) **Test 1**

This was generally well answered, although some incorrect asserted that a squeaky pop was produced using a lighted splint for the gas test.

Test 2

This was less successfully answered. Candidates often added far more **R** (hydrogen peroxide) than was needed to produce a visible change and generated a blackish precipitate of iodine. Candidates should be encouraged to add reagents a single drop at a time when asked to do so.

Test 3

Most candidates performed well. Words such as ‘chalky’, ‘misty’ or ‘cloudy’ are sometimes thought to be acceptable substitutes for ‘white precipitate’.

Test 4

Many candidates gained credit here, although a few thought that the precipitate was cream coloured or even white.

(ii) This was well answered by those candidates who had made correct observations in **Test 3**, although magnesium was sometimes given.

(iii) This was well answered by those candidates who had made correct observations in **Test 4**.

(b) (i) **Test 1**

This was poorly answered, with only effervescence reported by most candidates. The instruction to ‘wait until no further change is seen’, was seemingly overlooked, so that the fading of the blue solution and the deposition of orange-pink metal were missed.

Test 2

The formation of a blue precipitate, which was insoluble in excess NaOH, was widely described.

Test 3

This was less successfully answered. Candidates in some cases added too much NaOH at the start, so that the initial blue precipitate was missed. True drop-by-drop addition would avoid this.

(ii) Those who observed the blue precipitate formed in **Test 2** and/or **Test 3** usually identified copper(II) as being present in **T**. The correct oxidation state was also required – copper or Cu alone were insufficient.

CHEMISTRY

Paper 5070/41
Alternative to Practical

Key messages

- Candidates continue to find the free response planning question the most difficult, although there was a general improvement in this years performance.
- As stated in previous reports, it is very important that candidates take time to read each question carefully and thoroughly before answering.

Comments on specific questions

Question 1

(a) Many candidates were able to identify a condenser. Incorrect answers included fractionating column and burette.

Many candidates were able to identify a round bottom flask. Incorrect answers included conical flask, graduated flask and volumetric flask.

(b) This question was frequently answered with insufficient detail. Simply stating that the water was wrong was insufficient. Candidates needed to be specific about how the water flow should be.

The apparatus has two bungs in the diagram. Stating that the bung was wrong, or no bung was needed was insufficient. Candidates needed to make it clear which bung they were describing.

(c) (i) A wide variety of incorrect answers were given for this such as ‘the flask burning’ or ‘getting too hot’ or ‘breaking’. Others referred to the volatility of the ethanol or ‘it boiling too quickly’. The correct answer needed to refer to the flammability of the contents.

(ii) Many candidates correctly suggested a suitable piece of apparatus. Some referred to a Bunsen burner again and some omitted the question.

(d) The most common error was candidates referring to liquid leaving the condenser. Some candidates realised that the vapours would turn back to liquid but did not talk about it returning to the flask.

Question 2

(a) (i) This question was well answered with only a few candidates suggesting tests for other gases.

(ii) Few candidates realised that the solid was no longer visible in the mixture. Many repeated the observation relating to a gas forming, for example effervescence.

(b) Most candidates entered the figures correctly.

(c) (i) There was a wide spread of answers to this question. Candidates need to be able to identify anomalous results from a set of data by looking for a value that is out of the pattern.

(ii) The idea of repeating the experiment was well known. A number of candidates referred to plotting a graph, but this was insufficient and they had to go on to write about the anomalous point not lying on or being close to the best-fit line.

(iii) The most common error was to suggest experiment 1. Candidates need to be able to understand the relationship between time and rate when looking at data.

(iv) Many candidates answered this correctly even when they had not correctly answered **(iii)**.

(d) Some candidates incorrectly suggested a catalyst but most suggested at least one correct answer.

Question 3

Candidates continue to have difficulty in describing an experiment in a clear and sequential method.

Some candidates did not read the question sufficiently and suggested techniques using chemicals or equipment that were not available.

Some candidates had difficulty because they did not know the appropriate tests.

Some candidates did not realise that it was sufficient to identify the metal ion in order to identify the whole compound. They therefore went on to try to identify the chloride ion even though chemicals were not available to do this. This often led to confusion and contradictions in their answers.

It was essential that candidates made clear which substance they were identifying by the tests they described.

Question 4

(a) Most candidates could correctly calculate this value.

(b) Most candidates were familiar with this gas test. Some candidates incorrectly suggested a glowing splint rather than a lighted splint or other source of a flame.

(c) Many candidates did not seem to understand what the question referred to and suggested repeating the experiment, removing the solid or performing further processes on the filtrate. Candidates could wash the residue with either water of dilute sulfuric acid.

(d) Many candidates knew that the flask needed to be washed and the washings added to the volumetric flask, but few knew that this should be done more than once to ensure that all the liquid was removed.

(e) Most candidates answered this correctly.

(f) A wide variety of answers were given for this question. Some suggestions had no relation to the context. Water was a common incorrect answer.

(g) The majority of candidates were familiar with this type of question and could read and record the values correctly.

A significant number of candidates still do not record all values to the appropriate number of decimal places. In particular, they should write 0.0 rather than 0.

Some candidates averaged all values rather than selecting the most appropriate ones.

(h) – (l) Candidates answers broadly fell into two groups. Those who understood mole calculations and therefore performed well, with just the occasional numerical error, and those who performed poorly and gained little credit.

Question 5

(a) A significant number of candidates did not recognise that it is the compound or ion of a transition metal that causes the colour. Simply stating that a transition metal was present is incorrect.

(b) (i) Most candidates correctly described a green precipitate.

(ii) Most candidates correctly described a green precipitate or stated that no further change took place. Candidates could not gain credit for stating that no further change took place unless they had correctly identified a green precipitate in **(b)**.

(c) (i) Most candidates correctly described a green precipitate.

(ii) Although many candidates recognised that the precipitate dissolved, few described the resulting green solution.

(iii) Most candidates recognised that the litmus turned blue, but few identified the gas as ammonia.

(d) The test for chloride was well known even by candidates who incorrectly described a test for chloride in **Question 3**.

Question 6

(a) Most candidates recognised that the question related to precision or accuracy, but a significant number did not make it clear which piece of apparatus was more precise/accurate. Stating that a burette is accurate is insufficient unless compared to the accuracy of the measuring cylinder.

(b) There were a variety of answers which could gain credit, but the majority referred to the fact that the mass of precipitate had become constant. Some candidates used ideas of a limiting reagent. Simply stating that the reaction had stopped was insufficient.

(c) Some candidates found the scale on the graph difficult to use and so plotted points incorrectly.

Some candidates did not understand the idea of two separate straight lines intersecting and drew a curve or three straight lines instead.

(d)(i)(ii) Candidates who correctly plotted the graph, and so understood the scales, could generally read the values correctly.

(e)(i) A significant number of candidates did not appreciate that the question required them to read the point of intersection from the graph.

(ii) Candidates who had an incorrect answer to **(e)(ii)** could gain credit on this question through error carried forward.

A significant number of candidates omitted this question.

CHEMISTRY

Paper 5070/42
Alternative to Practical

Key messages

- Candidates should be familiar with the factors affecting rates of reactions as stated on the syllabus. These are:
  - concentration of solutions
  - pressure of gases
  - particle size of solids
  - temperature
  - catalyst

- Burette readings should be recorded to 1 decimal place even if the first digit after the decimal point is a zero. Thus 0.0, as opposed to 0, is correct.

Question 1

(a) This was answered fairly well. Apparatus **A** was slightly more well-known than apparatus **B**.

(b) Candidates were imprecise in their answers to this question. Those who referred to the positions of the water in and water out often commented that they were wrong without saying that they should have been reversed. Those who stated that the bung should not be present often omitted to mention that they were referring to the bung in the conical flask, as opposed to the bung in the fractionating column.

(c) (i) Some candidates correctly referred to the flammability of the alkanes. The most common incorrect response was that the flask would break or would be damaged.

(ii) Only a small number of candidates realised that the boiling point of water was lower than the boiling points of the alkanes A significant number simply said that the boiling water temperature is insufficient without giving a comparison involving the boiling points of the alkanes as well.

(iii) Only a small number of candidates gave a correct response. A water bath was seen quite often, despite **(c)(ii)** stating that a beaker of boiling water could not be used.

(d) A large majority realised that octane would be the first alkane to be collected and gave the correct reason as octane having the lowest boiling point. The most common error was to state that octane merely has a low boiling point.

(e) The majority of candidates were unaware that the purpose of the fractionating column was to separate the alkanes. The most common incorrect response was that apparatus **B** cools or condenses the vapours. This was only partially correct and was insufficient to gain credit.

Question 2

(a) (i) The majority of candidates knew the test for hydrogen gas. A common error was to use a glowing splint or just a 'splint.'

(ii) Most candidates gave answers which were not observations. Stating that the solid disappears was the simplest way to achieve the mark.

(b) (i) Only half of the candidates realised that experiment 4 gave an anomalous result. The most common incorrect answer was experiment 5. It is possible that the word 'anomalous' was not well known.

(ii) Only half of the candidates suggested repeating the experiment. Several gave an insufficient response of simply plotting a graph, without qualification.

(iii) The majority of candidates realised that experiment 5 gave the greatest reaction rate. The most common incorrect response was experiment 1.

(iv) The majority of candidates realised that the reaction rate increases as the temperature of the dilute sulfuric acid increases. The most common incorrect response was that reaction time decreases. The question asked about rate as opposed to time.

(c) More than half of the candidates realised that it would be difficult to measure reaction time accurately at 90 °C because the reaction would be too fast. The most common incorrect/insufficient response was that the reaction would take less than one or two seconds.

(d) This was answered quite well. The most common incorrect variable was pressure, which only affects the rate of reactions involving gases. Amounts and masses were also occasionally seen.

Question 3

There were some excellent answers to this question gaining full credit. These answers were organised in a systematic fashion and were thus easily understood. On the other hand, a significant number of candidates left the answer space blank.

The most common correct responses were giving the correct test for chloride ions in hydrochloric acid and the correct observation of white precipitate when aqueous sodium hydroxide was added to both aqueous aluminium sulfate and aqueous zinc sulfate. The most common errors were to observe hydrogen gas evolved in testing for HCl and adding nitric acid instead of ammonia in the tests for aluminium and zinc sulfates.

Candidates often suggested testing for the sulfate ions in aluminium and zinc sulfates. This would not distinguish between aqueous aluminium sulfate and aqueous zinc sulfate. In addition, the reagents for a sulfate test were not provided.

Question 4

(a) The vast majority of candidates correctly calculated the mass of the mixture used in the experiment.

(b) This was answered correctly by only a small number of candidates. Water was the most essential part of the answer. Incorrect responses included: filtering again; squeezing the sand on the filter paper; leaving it to dry; washing without mentioning water. Some candidates suggested that measurements, usually of mass, needed to be made.

(c) This was answered correctly by only a very small number of candidates. Some mentioned washing out the conical flask and transferring the contents to the volumetric flask. Hardly any suggested that the process should be carried out more than once.

(d) Only a minority of candidates realising that a bulb/pipette filler should be used with the pipette. The most common incorrect response was burette. Candidates obviously did not appreciate the significance of the phrase 'with the pipette'.

(e) Only an extremely small number of candidates were aware of this colour change. By far the most common incorrect response was purple or pink to colourless, which is the reverse of the correct colour change.

(f) The most common error, seen very frequently, was to record 0 instead of 0.0 and 26 instead of 26.0. The other readings and the average were usually correct.

(g)-(j) These parts were answered reasonably well. There were no common errors.

(k) Those candidates who achieved an answer in **(j)**, which was greater than their mass in **(a)**, would have achieved an answer to **(k)** which was greater than 100 per cent. This is an impossible answer and candidates should have been alerted to check the earlier stages in the calculation. There was no evidence that this was the case.

Question 5

(a) Very few candidates stated that **S** was a compound containing a transition element or metal, or that **O** contained ions of a transition element or metal.

(b) (i) This was answered well by many candidates. The phrase 'soluble precipitate' should be avoided due to the contradiction in terms.

(ii) Those who mentioned that the precipitate dissolved should have gone on to mention that a dark blue solution was formed. Only a small number of candidates did this.

(c) (i) This was answered well by many candidates. There were no common errors.

(ii) This was answered reasonably well. There were no common errors.

(iii) Large numbers of candidates realised that the red litmus turned blue. However, most candidates omitted to name the gas formed, despite the requirement in the question.

(d) This was answered reasonably well. Common errors included: adding sodium hydroxide solution; adding barium sulfate; adding silver nitrate; incorrect formula for barium chloride or barium nitrate.

Question 6

(a) This was answered quite well. The most incorrect responses did not use a comparison but merely stated that a burette is accurate or precise.

(b) This was answered quite well. The most incorrect responses said that the temperature increases then decreases. Alternatively, candidates stated that temperature increase gets bigger as the volume of **X** increases (up to experiment 4) instead of referring to the fact that all the temperatures increase or any one of the experiments produces a temperature increase.

(c) This was answered very well with a large majority plotting all points correctly then drawing two ruled intersecting straight lines.

(d) (i) This was answered quite well. The most common error was misreading the graph to give an answer of 10.1 °C instead of the expected 10.5 °C.

(ii) This was answered quite well. The most common error was the misreading of the volume of *x*-axis.

(e) (i) Many candidates found this challenging. The most common error was an answer of 5.0 cm^3, presumably obtained from using the first point on the graph or results table.

(ii) A small number of candidates carried out the calculation perfectly. The working out was shown clearly. However, in several cases the calculation was not attempted.