CHEMISTRY

Paper 5070/11
Multiple Choice

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

General Comments

Candidates are advised to read the stem of each question very carefully. On many occasions missing the significance of just one word in the stem of the question can alter the interpretation of the problem that has been set.

Comments on Specific Questions

Question 2

Candidates who misread the question gave the composition of the non-radioactive isotope of carbon as their answer.

Question 7

Graphite conducts electricity by the movement of electrons only.

Question 11

Confusion over the colour change which takes place when iodide ions are oxidised to iodine was the downfall of many candidates.

Question 15

This question involved straight recall of the syllabus. The distribution of the answers indicates that many candidates are not secure in their knowledge of this syllabus area.

Question 21

The anode must have had a mass even at the beginning of the electrolysis and thus alternative **D** was incorrect.

Question 23

This was another question which relied upon simple recall of the syllabus. Sulfur dioxide is made during the manufacture of sulfuric acid but it is not a raw material in the manufacture of the acid.

Question 40

Both alcohols and carboxylic acids contain an –OH group with only carboxylic acids also having an oxygen atom bonded to the same atom as the one to which the –OH group is bonded.

CHEMISTRY

Paper 5070/12
Multiple Choice

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

General Comments

Candidates are advised to read the stem of each question very carefully. On many occasions missing the significance of just one word in the stem of the question can alter the interpretation of the problem that has been set.

Comments on Specific Questions

Question 1

Crystallisation is a good method of obtaining sugar from an aqueous solution of sugar but distillation is a good method of obtaining the water from an impure sample of water, thus alternative **B**, distillation, is the correct answer to the question.

Question 2

Catalysts increase the rates of both the forward and backward reactions equally without altering the concentrations of the substances present at equilibrium. Thus the alternative **C** which was favoured by many of the candidates was incorrect.

Question 6

Alternative **B** proved to be a strong distractor. It is atoms and not ions which have the same number of electrons as protons.

Question 9

The distribution of the answers suggests that many candidates were unsure of how to work out the answer. Each carbon atom has two electrons not involved in bonding and each oxygen atom has six electrons not involved in bonding making alternative **D** correct.

Question 17

This question relied on candidates appreciating the need to convert between grams and moles to work out the correct answer.

Question 20

The chemical name for sand is silicon dioxide and its conversion to silicon involves the loss of oxygen which is reduction.

Question 30

Alternatives **B** and **C** were the two most popular answers with both gases turning moist blue litmus paper red. Finally to obtain the correct answer to the question it was necessary to realise that calcium chloride is soluble in water and that calcium carbonate is insoluble.

CHEMISTRY

Paper 5070/21
Theory

Key Messages

Candidates must read the questions carefully and answer the question that is set. To be successful in calculations candidates must organise their answers in a clear and coherent way making certain that the working out is clearly explained.

Candidates did not have a clear understanding of the kinetic theory of matter and used collision theory instead.

General Comments

Good answers to questions used the correct chemical terms but many candidates gave imprecise answers to questions that needed a longer response.

Candidates did not always organise their answers to quantitative questions which made it difficult to award marks for errors carried forward. Candidates should be advised to show all the steps in a calculation so that Examiners can easily credit the working out when an answer is incorrect.

Comments on Specific Questions

Section A

Question A1

(a) Many candidates recognised the equation that made ammonia.

(b) Many candidates recognised the equation that made the white precipitate, barium sulfate. A common error was to choose the equation that made copper(II) hydroxide.

(c) Some candidates chose the equation that involved the reduction of copper(II) ions but a significant proportion of the candidates chose one of the other equations that involved an electron.

(d) The reaction of hydrogen ions with hydroxide ions was often chosen by the candidates.

(e) Many candidates chose the equation showing the oxidation of copper to copper(II) ions rather than the one involving the oxidation of hydroxide ions to give water and oxygen.

Question A2

This question involved the combustion of contaminated methane at a power station.

(a) Some candidates could write the equation for the combustion of hydrogen sulfide, however, many did not use the correct formulae for the products and so could not construct the balanced equation.

(b) Candidates often linked the gas sulfur dioxide with acid rain but did not always write about possible global warming as a result of the production of carbon dioxide. Some candidates gave a list of environmental effects but did not link them to a particular gas. A small proportion of candidates referred to environmental problems due to the presence of methane instead of the combustion products.

(c) (i) There was very little evidence from the candidates' working out that they used the equation in the stem to calculate the answer of 999 dm^3 even though a significant proportion of the candidates did give this answer.

(ii) Although some candidates left this calculation blank, a significant number of candidates were able to calculate the volume of hydrogen sulfide as 1 dm^3.

(iii) Many candidates appreciated how to calculate the percentage of hydrogen sulfide as 0.1%. Some candidates were awarded a mark for error carried forward using an incorrect answer from **(ii)**.

(d) (i) Many candidates were unable to describe that the volume of the gas decreases. The most common misconception was to give answers that related to rate of reaction and collision frequency with answers stating that there were more collisions. Only the very best answers correctly referred to the kinetic theory of matter in their explanation.

(ii) Candidates found this question as demanding as part **(i)**. Many candidates had the same misconception as in **(i)**, describing collision theory and rate of reaction. Candidates did not often mention that the particles in the gas move faster and spread out.

Question A3

This question was about the thermal decomposition of zinc carbonate.

(a) The best answers referred to the activation energy not being reached at the start of the reaction. Other candidates referred to the idea that at the start the temperature was not high enough.

(b) Candidates often appreciated that the decomposition had finished when the line on the graph was horizontal. A common misconception was to refer to the line being straight rather than horizontal.

(c) Although many candidates realised that the graph should be steeper than the original many drew lines that either finished with a greater volume of gas than the original or smaller volume of gas than the original. The best explanations referred to the reaction being faster in terms of collision theory. Many candidates did not use collision theory in their answer.

(d) Candidates often appreciated that the time of complete decomposition was related to the reactivity of the metal in the carbonate. The best answers stated that the more reactive a metal the longer it takes its carbonate to decompose. A common misconception was to refer to the reactivity of the carbonate rather than the metal.

Question A4

This challenging question was about aluminium oxide.

(a) Candidates found both equations very difficult to recall. Candidates were more likely to recall the equation for the reaction at the negative electrode rather than the one at the positive electrode. The equation for the reaction of oxide ion to make oxygen was often incorrect with the electrons being shown on the wrong side of the equation. Other candidates did not balance this equation either in terms of atoms or charge or both. A common misconception for the reduction of aluminium ion was to write $Al^{3+} + 3e^- \rightarrow 3Al$.

Candidates used a variety of incorrect representations for electrons including e^{2-} or e^+.

(b) The importance of the aluminium oxide layer was well known to candidates but many did not take their answer any further and did not mention that the oxide layer was unreactive or impermeable to oxygen and water.

(c) Candidates often appreciated that the magnesium was more reactive than iron and that it would react instead of iron. The term sacrificial protection was often used by candidates. A common misconception was to assume that the magnesium was a layer over the pipe rather than a lump attached to the pipe.

(d) Candidates found the preparation of aluminium sulfate from aluminium oxide extremely challenging. Some candidates recognised that the aluminium oxide had to be reacted with sulfuric acid. Many candidates used a titration method to make this salt, assuming that aluminium oxide was soluble in water. Other candidates used a precipitation method reacting aluminium oxide with aqueous solutions of soluble sulfates such as potassium sulfate.

Only a small proportion of the candidates described the correct preparation using an insoluble base and dilute sulfuric acid. Most candidates did not appreciate the importance of using excess aluminium oxide or the importance of filtering off this excess.

Candidates often described how to get crystals from an aqueous solution but the solution often would not have contained aluminium sulfate.

Question A5

This question was about ethene.

(a) Candidates were often able to draw the correct dot-and-cross diagrams although some candidates only showed one shared pair of electrons between the carbon atoms.

(b) The equation for the hydration of ethene was well known by some candidates, while other candidates left the question blank. The need for a catalyst, high pressure and high temperature was well known but sometimes a temperature was given that was not in the acceptable range given in the mark scheme. A small proportion of the candidates confused the hydration of ethene with fermentation.

Question A6

Many candidates realised that this question was concerned with the chemistry of copper and its compounds however they often gave incorrect names for the unknown substances. Carbon dioxide was often recognised even if the other substances were incorrect. Copper carbonate was frequently identified, as was copper sulfate, but candidates found the last three unknowns much more demanding. Most candidates used names to identify the substances. Those that gave formulae often used incorrect formulae and so were not awarded the marks.

Section B

Question B7

This question was about cyclobutane.

(a) The best answers either referred to the lack of double bonds in the molecule or stated that all of the bonds were single bonds. A common misconception was to state that a molecule of cyclobutane had single bonds without stating there are only single bonds present.

(b) Many candidates were not able to deduce the empirical formula for cyclobutane. The molecular formula was sometimes given by candidates.

(c) Many candidates gave the structure for but-1-ene and some for but-2-ene. A few candidates included structures with pentavalent or trivalent carbon atoms. Other candidates gave structures that were not alkenes.

(d) (i) Candidates were often able to write the equation for the complete combustion of cyclobutane. Other candidates made minor errors in balancing but were able to give the correct products.

(ii) Candidates did not always show clear working out for this calculation but often quoted 67 550 kJ as the correct answer. A common misconception was to use 22.4 dm^3 instead of 24 dm^3 as the molar volume of a gas at room temperature and pressure. Candidates who used this approach were awarded one mark. A significant proportion of the candidates did not attempt this question.

(iii) Candidates did not always organise their answers with sufficient clarity. The best answers involved three sentences, sometimes written as bullet points:

- Bond breaking absorbs energy.
- Bond making releases energy.

- More energy is released than absorbed.

Many candidates had answers that confused bond breaking and bond forming and other answers involved both bond making and bond breaking absorbing energy.

Question B8

This question focused on butanoic acid and ethanoic acid.

(a) Candidates often appreciated that a weak acid was only partially ionised but did not write an equation involving a reversible reaction.

(b) Many candidates appreciated that hydrogen was a product of the reaction between magnesium and butanoic acid. The candidates often described the correct chemical test for hydrogen although some candidates used a glowing splint rather than a burning splint. There was no error carried forward mark for candidates who thought carbon dioxide was produced in the reaction.

(c) Candidates found this question very challenging. Many did not deduce the formula of the butanoate ion and included one extra hydrogen atom. Even with the correct formula for the anion many candidates did not appreciate that there were two butanoate ions to one magnesium ion. Some candidates gave the formula as $(C_4H_7O_2)_2Mg$ which was accepted in the mark scheme.

(d) The structure of ethyl ethanoate was often well drawn by candidates although there were some structures with monovalent oxygen atoms. Most candidates followed the instruction to draw all the atoms and all the bonds rather than drawing condensed structures.

(e) The best answers had clear working out that allowed some degree of error carried forward to be awarded. Some candidates guessed a carboxylic acid and then tried to use the numbers to contrive a calculation to get to their chosen carboxylic acid. A significant proportion of the candidates did not attempt this question.

Question B9

This question focused on the reaction of carbon dioxide and hydrogen to make methane and water.

(a) Candidates often confused rate of reaction and position of equilibrium and as a result gave answers that referred to the position of equilibrium moving to the right. The best answers appreciated that the rate of reaction increased because the particles were closer together and so there were more collisions per second

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

(c)(i) Some candidates were able to calculate that the mass of methane made was 80 g. Candidates did not always clearly show their working out.

(ii) Some candidates could work out the percentage yield as 57.5 but a significant proportion were not able to attempt the question because they did not attempt part **(i)**.

(d) (i) Most candidates did not appreciate that a catalyst does not affect the position of equilibrium. Many answers referred to the rate of the reaction or the time taken to reach equilibrium. Other candidates suggested that that the position of equilibrium moved to the right.

(ii) Candidates often answered this question very well and referred to the lowering of the activation energy and/or the use of an alternative pathway.

Question B10

This question was about the radioactive element francium.

(a) Candidates often could deduce the correct number of electrons but had much more difficulty with the correct atomic symbol. Most errors involved the atomic number rather than the mass number of the element.

(b) Many candidates wrote an equation involving the formation of francium oxide rather than francium hydroxide.

(c) (i) Many candidates could describe how the francium ion and the oxide ion could be made from the respective atoms. The most common errors centred around the use of oxide atoms or astatine ions.

(ii) Many candidates appreciated that francium oxide would have a high melting or boiling point but failed to give another property with sufficient clarity to be awarded a mark. Candidates often referred to electrical conductivity but did not always refer to the state of the francium oxide. A common misconception was that candidates gave answers referring to properties of francium e.g. a soft metal rather than francium oxide.

(d) Many diagrams did not include labels for the electrons and the positive ions. A common misconception was to have the electrons on the outside of the closely packed metal ions and not dispersed between them. Candidates often appreciated that the electrical conductivity of metals could be explained by the movement of the electrons. Some candidates referred to intermolecular forces or drew structures that looked like an ionic lattice. These answers were not given a mark for the structure of a metal.

CHEMISTRY

Paper 5070/22
Theory

Key Messages

In questions involving equilibrium reactions, a clear distinction needs to be made between questions involving rate and questions involving extent and direction of the equilibrium.

Many candidates need more practice at answering questions about practical aspects of chemistry.

General comments

Many candidates tackled this paper well and gained good marks in both ***Sections A*** and ***B***. The majority of candidates attempted most parts of each question. In general, ***Section B*** questions were answered as well as those in ***Section A*** and in ***Section B*** most candidates gave answers of the appropriate length to questions involving free response.

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 how to construct ionic equations. More practice is required in constructing these and in identifying species which exist as diatomic molecules. Many candidates wrote oxidation numbers after uncombined elements, Fe(II) being a particularly common error. Candidates need to understand that the oxidation number of an uncombined element is zero.

Practical aspects of chemistry as in **Question A3 (c)** on chromatography and in **Question A6**, the observational question about iron and iron compounds, posed challenges for many candidates. The answers to the former often showed the spots of amino acids and locating agent being placed in the solvent. Many candidates did not take notice of the word ‘observe’ in the stem of **Question 5 (d)(ii)** and wrote about the nature of the substances formed or type of reaction.

Some candidates’ knowledge of structure and properties in terms of atoms, ions and electrons was fairly good. Others need more practice in areas such as explaining the structure of metals and explaining using the information in an equation, why a reaction is a reduction reaction. Many could write electronic structures of ions (NaF) and molecules (astatine). Others did not use the idea of completely filled outer shells when constructing their diagrams.

Many candidates need practice at explaining why an increase in temperature increases the rate of reaction. Many gave an explanation in terms of collision frequency instead of an increased number of successful collisions. In question **B9** on equilibrium and rate aspects of the reaction between iron and steam, candidates confused rates of reaction with equilibrium.

Many candidates performed fairly well on the main questions about organic chemistry (**Questions B7** and **B8**). Others need more practice at balancing organic equations and writing the structure of esters. However, **A3 (d)**, requiring the name of the compound formed when macromolecular carbohydrates are hydrolysed, was not well attempted.

Many candidates performed well in questions involving calculations, showing appropriate working and clear indications about what each number referred to. In order to gain appropriate marks, candidates should make it clear why they are performing certain steps and need to take care with the application of rounding and significant figures. Many relatively low scoring candidates were able to gain full marks for some of the calculations. The exceptions were **Question A2 (c)(ii)**, requiring proof that an answer is correct, and **B8 (c)** which required the calculation of the relative atomic mass of lithium.

Comments on specific questions

Section A

Question A1

This question was well answered.

(a) This part was least often correct. The commonest error was to suggest carbon dioxide.

(b) Most candidates gave a correct answer. Most suggested methane but carbon dioxide and nitrogen were also acceptable.

(c) Most candidates recognised the chlorofluorocarbon. A few gave the incorrect formula and so were not awarded the mark. Some suggested methane or carbon dioxide, a confusion with greenhouse gases.

(d) The majority of candidates realised the importance of hydrogen in margarine manufacture. The commonest incorrect answer was sulfur dioxide.

Question A2

Few candidates scored well on this question. The calculations proved difficult for some; others performed well on these parts. Incorrect rounding was often seen in calculations.

(a) Many candidates were able to do this calculation but a considerable number did not round their value correctly.

(b) (i) Many candidates succeeded in writing the correct ionic equation. Some tried to include calcium and others wrote equations which were molecular, or half word and half molecular.

(ii) Many candidates scored both marks. Most of those who suggested that ammonia was formed also went on to state that ammonia is a gas. The main misconceptions were to suggest that nitrogen gas is formed or to write about nitrogen, ammonia or ammonium salts dissolving in the soil water.

(c) (i) The majority of candidates were able to calculate the concentration of aqueous ammonia. Common mistakes were to miss the multiplying the moles of phosphoric acid by 3 or to divide this by 3. Many candidates showed their working and so gained at least some of the marks.

(ii) Many candidates who scored in part **(c)(i)** also scored here. The marks were awarded for the working rather than the answer. A significant number of candidates either made up numbers to give an approximation to the correct answer or did not respond to this question.

(iii) A significant proportion of the candidates calculated the percentage yield correctly.

Question A3

Many candidates gained marks in parts **(a)**, **(b)** and **(e)**. Few scored all four marks in the chromatography question (part **(c)**) and few knew the hydrolysis products of macromolecular carbohydrates (part **(d)**).

(a) Most candidates recognised the amide link, though some suggested amines, polyamides or esters.

(b) Most candidates knew that nylon is a polyamide. A few suggested polyesters.

(c) Many candidates were not familiar with chromatographic technique. The marking point for the paper dipping into the solvent was the one most usually given. Common mistakes were to add the amino acid mixture to the solvent or to adding locating agent to the solvent. The marking point for the placing of the spot of amino acid on the paper was often not given because: the spot was touching or in the solvent; the spot was referred to as a dye; the spot was called the protein; locating agent was added to the spot before chromatography. Many candidates mentioned the use of a locating agent but some thought that it was a dye that was added. Few candidates explained how the amino acids could be identified: many mentioned the R_f value but did not explain how this could be used to identify the amino acids.

(d) Very few candidates realised that the products of hydrolysis of a macromolecular carbohydrate are simple sugars. Many suggested alcohol or left the answer line blank. Glucose was the most common incorrect answer. This was not awarded because it is a specific carbohydrate rather than a type of carbohydrate.

(e) (i) Many candidates realised that unsaturation referred to double bonds but fewer realised that these were carbon–carbon double bonds. Many suggested, incorrectly, that unsaturation refers to C=O bonds. A considerable number of candidates did not mention that there were many double bonds. Other non-creditworthy answers included the idea that unsaturated compounds contain only single bonds and ideas about fats which were not relevant.

(ii) The majority of candidates gave the correct test for unsaturation. A few reversed the colour change or suggested that the bromine went clear or discoloured. A considerable minority gave a test for fat (e.g. involving the addition of water and shaking to see a cloudy suspension) rather than for unsaturation.

(iii) A majority of the candidates correctly identified a polyester or a named polyester. The commonest incorrect answer was nylon.

Question A4

Many candidates scored well on this question, identifying at least three of the electrode products correctly in part **(a)** and recognising that the discharge is related to the reactivity series. Many candidates wrote the ionic equation for the discharge of chloride incorrectly, reflecting the need for more practice in this area of equation writing.

(a) Many candidates correctly identified the anode and cathode products. Some scored two marks because they wrote hydrogen instead of copper as the cathode product during the electrolysis of aqueous copper(II) sulfate. Many did not get the marks because they wrote the formulae of ions instead of elements. Others wrote incorrect formulae such as Br or O or Pb(II). Candidates should be discouraged from using oxidation numbers for elements.

(b) (i) Few were able to construct an ionic equation for the formation of chlorine at the anode. Common errors were: to reverse the equation; to put the electrons on the wrong side e.g. + $2e^-$ on the left; incorrect balance of the chloride ion.

(ii) The majority of candidates gave a correct answer in terms of the reactivity series. A significant minority suggested that hydrogen is more reactive than sodium. A few referred to the discharge series.

(c) A significant proportion of candidates identified a suitable element which could be extracted using electrolysis. The commonest incorrect answer was lead. Other incorrect answers included copper and silver.

Question A5

This was one of the more challenging questions on the Paper. Part **(a)** was well done by the majority of candidates but part **(d)** proved to be testing, especially in part **(ii)** where observational practical skills are required.

(a) Most candidates scored at least one mark, usually for the use of the haematite. Many candidates did not gain the mark for the use of the limestone because no mention was made of the limestone decomposing to form calcium oxide. A significant number thought, incorrectly, that limestone lowered the melting point of the mixture in the furnace or that it acted as a catalyst. Many candidates understood the use of coke in the blast furnace either for providing heat or for reducing the iron oxide. Many explained correctly that the coke formed carbon monoxide. A considerable minority lost this mark because they suggested that carbon dioxide reduced the iron oxide.

(b) Many candidates either did not label their diagrams or give correct terms on the answer lines.

(c) Malleable was the correct choice most often seen.

(d) (i) Some candidates gave a correct explanation of reduction in terms of electron transfer though many only referred to the iron and not the iron(II) ions. The iron is on the right hand side of the equation. The correct species which gain the electrons is the iron oxide or iron(II) ions. A significant minority did not read the stem of the question carefully enough and referred to oxidation number changes rather than electron transfer.

(ii) Many candidates seemed unaware of what is meant by the term observe. A considerable number wrote about iron being formed or magnesium going into solution, or it being a displacement reaction. Others gave incorrect observations such as: formation of a green precipitate; precipitates dissolving; iron forms a red-brown solid.

Question A6

Metal **A** was often correctly answered though many candidates suggested incorrectly iron(II). The green solution **B** was only identified as iron(II) chloride by the better candidates. Most suggested either Fe(II) or Fe^{2+}. Gas **C** was usually identified correctly as hydrogen. The commonest error was to suggest carbon dioxide. Precipitate **D**, solution **E** and precipitate **F** were rarely identified correctly. Fe(II) or Fe^{2+} and Fe(III) or Fe^{3+} were commonly seen as well as a range of oxides, chlorides and bromides instead of hydroxides (for **D** and **F**).

Section B

Question B7

As in previous sessions, questions requiring the balancing of organic equations proved demanding for some candidates. Many were able to deduce the formula of the alkane in part **(d)(ii)** and most recognised the cracking reaction.

(a) Most candidates gained at least one mark. The branched chain alkane was not always correctly drawn. The commonest mistakes were to miss one or more H atoms or to write a second straight chain, the end of which bent around at 90^{o}.

(b) (i) Few candidates were able to balance the equation. Many put $7O_2$ rather than $13O_2$. The most successful candidates tended to balance the oxygen with 6½.

(ii) Most recognised the problems associated with incomplete combustion. The commonest answer was to suggest the formation of carbon monoxide.

(c) Some candidates were able to balance the equation. The commonest error was to give hydrogen as a product.

(d) (i) Most candidates identified cracking. A small number wrote decomposition without the thermal (thermal decomposition was credited) and a few suggested reduction or endothermic.

(ii) The majority of candidates were able to do the calculation to deduce the formula. A few attempted a calculation without considering hydrogen and so scored zero. A considerable number gave 84÷12 and 16÷1 but then gave incorrect ratios. Common incorrect answers were CH_2 or CH_3.

(iii) Many candidates gave the correct formula by subtraction and many gained the mark through error carried forward from part **(ii)**. A considerable number of candidates did not respond to this question.

Question B8

As in previous sessions, candidates did not score well on questions involving balancing organic equations and drawing organic structures and often these parts were not attempted. The calculation in part **(c)** was generally well done and most candidates knew the test for hydrogen.

(a) Few candidates scored both marks. Many did not obtain the balance mark because one or more of the 2's used for balancing were absent. A considerable minority of the candidates wrote Na instead of K.

(b) Most candidates knew the test for hydrogen. A minority of candidates suggested using a glowing splint or gave the test for carbon dioxide.

(c) Many candidates were able to make a good start to this part even if they were not able to complete it correctly. A considerable number of candidates made guesses for the relative atomic mass or tried to manipulate the figures to make a convenient number.

(d) A good number of candidates were able to draw the structure of ethyl ethanoate. The main errors were: to omit one of the O atoms; to add another H atom to one of the oxygen atoms; to miss out one or more H atoms; to draw methyl ethanoate or methyl propanoate.

(e) The majority scored at least two marks though many did not include an equation or did not balance it correctly.

Question B9

In parts **(b)** and **(c)** many candidates confused ideas of equilibrium with those of rate of reaction. The calculation in part **(d)** was generally well done.

(a) The majority of candidates gave a good explanation of the term *endothermic*. Others went into too much detail in terms of bond breaking and bond making and lost marks by suggesting that bond formation requires energy.

(b) Few candidates scored more than one mark. Most tried to answer the question in terms of equilibrium rather than rate of reaction. Of the relatively small number of candidates discussing reaction rate, few gave the answer in terms of successful collisions. Most gave the answer in terms of collision frequency.

(c) Very few candidates realised that the position of equilibrium does not change if the number of gas molecules is the same on each side of the equation. Most ignored the gas molecules and suggested that the reaction goes to the right because there are more molecules on the right (to include the solids).

(d) Many candidates scored all three marks. Many others showed appropriate working and so obtained marks for errors carried forward. Common errors included omitting to divide by 3, or multiplying by 3.

(e) Many candidates scored two marks but a considerable number only gained one mark because they did not mention zinc in their answer. The idea of zinc forming a protective layer against oxygen and water was less popular than the idea of sacrificial protection. Many candidates' answers were a mixture of both methods, so they did not score full marks.

Question B10

Many parts were well answered especially parts **(a)(i)** and **(b)**. The definition of isotopes was not always accurate. Few candidates were able to write the balanced ionic equation in part **(d)(i)**.

(a) (i) Nearly all candidates gave the correct number of protons, electrons and neutrons.

(ii) Many candidates gave a good definition of isotopes. The main error was to omit the essential word *atom* from the definition.

(b) Many candidates drew the correct dot-and-cross diagram for astatine. The commonest error was to omit the non-bonding electrons.

(c) (i) Many candidates gave a correct description of how a magnesium ion and an astatide ion are formed. The idea of magnesium losing two electrons was usually correctly given but many candidates did not make it clear that an astatide ion is formed by the gain of one electron.

(ii) Many candidates did not know the difference between chemical and physical properties. Common errors were colour (often black or white) or mention of electrical conductivity but not making it clear whether this referred to the solid or aqueous state.

(d) (i) This part was not well answered. Many candidates wrote word equations or molecular equations rather than an ionic equation. Common errors included: addition of magnesium somewhere in the equation, often in association with At or Br; writing 2Br or 2At rather than the diatomic molecules; lack of balance.

(ii) Many candidates gained the mark for explaining the reactivity. The main errors were: stating that astatine is less reactive than iod<u>ide</u>; comparing the reaction of astatine with magnesium; comparing the position of astatine and iodine in the group rather than comparing the relative reactivity in the group.

CHEMISTRY

Paper 5070/31
Practical Test

Key messages

Candidates should be encouraged to read more carefully in order to prevent the unnecessary loss of marks.

In the qualitative exercise, candidates should be advised to follow each test's instructions precisely and to make full and accurate use of the Qualitative Analysis Notes provided.

General comments

Despite the exercise in **Question 1** not involving a titration, there were many candidates who followed the practical instructions well and obtained the data needed to plot the graph and answer the questions which followed. Supervisors are thanked for supplying the experimental results needed to facilitate the assessment. While there were a good number of candidates who handled the demands of the analysis in **Question 2**, there were many who could have scored more marks if they had consistently followed the instructions.

Comments on specific questions

Question 1

(a) Although most candidates supplied temperature readings for all the experiments, there were a considerable number who did not provide any indication that temperatures were being recorded to the nearest 0.5^{o}C – a single reading to either 0.0 or 0.5 was sufficient to secure the mark. Temperature rises were generally correctly calculated but mistakes were found. There was evidence that some candidates drew graphs based on a few or indeed no results and used them to find their temperature rises. The concentrations of **P** and **Q** requested in the confidential instructions produce an increase in temperature rise for experiments 1 to 3 and a fall for experiments 4 to 7, and this pattern was successfully obtained by most of the candidates. Many of the temperature rises were within 1.0^{o}C of the Supervisor's results and as a result it was not uncommon to find high scores in this part of **Question 1**.

(b) Data was usually correctly and clearly presented on the graph but sometimes not all the temperature rises were plotted. While the instruction to draw two intersecting straight lines was followed by most, there were a few examples of point-joining. Although it was not a requirement to score the second mark, it was good to find that some candidates used the points 0,0 and 50,0.

(c) The volume of **P** was generally successfully read from the intersection of the two lines.

(d),**(e)** Many candidates calculated the number of moles of acid in the volume of **P** recorded in **(c)** and realised that the same number was the answer to **(e)**. Indeed providing the answer in **(e)** was the same as that in **(d)**, one mark was always awarded for **(e)**.

Besides those who struggled to use the volume and concentration to determine the number of moles of acid in **(d)**, there were a few who used 24 000, and in **(e)** when the number of moles of sodium hydroxide was different from the answer to **(d)** the cause was usually due to some use of the relative formula mass of sodium hydroxide and/or hydrogen chloride. As a general point, it is worth informing candidates that any data such as relative mass or molar volume will be supplied when needed in calculations. Consequently, if such data is not supplied, it is not needed.

(f) This proved to be the most difficult part of **Question 1** and some candidates did not attempt it. Nevertheless, many recognised that the volume of **Q** was 50 minus the volume of **P** and most went on to calculate the concentration of **Q** correctly by dividing the answer from **(e)** by that volume and multiplying by 1000. There were also a number who chose not to use the answer from **(e)** and calculated the concentration using an equality of the kind $C_1V_1/N_1 = C_2V_2/N_2$.

Question 2

It was rare to find that all the tests had not been attempted. All the scoring points listed in the mark scheme were awarded in the assessment of examination scripts. The most successful candidates carefully followed the instructions and recorded observations clearly using appropriate terminology. While others displayed competence in some parts, they were inconsistent in their approach. Consequently, marks were lost for incomplete answers and inaccurate recording. When a gas is observed e.g. by the bubbling of a liquid, the gas should be tested and then identified. There is no credit to be gained by simply naming a gas without recording the observations.

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 marks for this question.

R was hydrochloric acid; **S** was sodium thiosulfate.

Test 1

The bubbling of the liquid caused by the addition of the magnesium to **R** was recorded by most candidates but the gas needed to be successfully tested before it could be identified as hydrogen. Despite the test and its result being available on the final page of the exam paper, there were a number of candidates who reported the test incorrectly. 'Pops with a glowing splint' (the most commonly offered wrong test), 'pops with a splint' and 'pops' are not acceptable identifications of hydrogen. The gas (mixed with air) has to be ignited to produce a 'pop' with a lighted splint. Despite recording the correct test, the gas was not always named.

The mark available for reporting that the metal disappeared was only occasionally awarded.

Test 2

Most candidates noted a white precipitate or solid was formed in **(a)**. It was good to find that there were very few examples of descriptions such as liquid turns milky or cloudy. A mark was given in **(b)** for any indication that the solid remained when nitric acid was added.

Test 3

Many recorded that the solution turned white or yellow but did not state that this was due to the formation of a solid. While the smell of the sulfur dioxide was rarely noted, the colour change of the filter paper was. This is a test for SO_2 and will be found in the Qualitative Analysis Notes from 2015. Candidates will be expected to use this test without instruction to identify SO_2 gas.

Test 4

The aqueous iodine was correctly reported to turn colourless or be decolourised by almost all candidates.

Test 5

There were some excellent examples of detailed observation as a result of careful execution seen in answers to this test. Providing a few drops of **S** were added, a white precipitate formed and then the colour of the solid gradually darkened, passing through yellow to red to brown, as it decomposed to silver sulfide. Plenty of candidates noted a precipitate but either did not record the darkening of its colour or did not observe it. Those who did not get any precipitation presumably did not follow the instruction and added too much **S**.

Test 6

In **(a)** the addition of **S** to the aqueous iron(III) ions initially produces a deep colouration, which is dark violet, and then this colour quickly disappears. Like **Test 5** this proved to be effective in discriminating between candidates. Some missed the darkening of the colour. Some believed a black or dark precipitate was produced. There was much variety in the observations supplied.

The reaction in **(a)** causes the reduction of iron(III) to iron(II) ions and so the precipitate formed when aqueous sodium hydroxide is added is green. The solid remains in excess of the alkali. Many recorded the formation of a precipitate and generally reported it to be green(ish). Given its prominence in observations associated with the tests for aqueous cations, it was disappointing to find so many candidates not scoring the mark for the precipitate being insoluble in excess.

Conclusions

Candidates who reported a white solid in **Test 2** which remained in nitric acid, almost always identified the anion in **R** as chloride. They were less assured in identifying the cation in **R** as hydrogen despite the reaction of the metal recorded in **Test 1**.

Test 4 convinced many candidates that **S** had been involved in a redox reaction but those offering an answer in the conclusions were equally split between it being a reducing or an oxidising agent.

CHEMISTRY

Paper 5070/32
Practical Test

Key messages

Candidates should be encouraged to read more carefully in order to prevent the unnecessary loss of marks.

In the qualitative exercise, candidates should be advised to follow each test's instructions precisely and to make full and accurate use of the Qualitative Analysis Notes provided.

General comments

Despite the exercise in **Question 1** not involving a titration, there were many candidates who followed the practical instructions well and obtained the data needed to plot the graph and answer the questions which followed. Supervisors are thanked for supplying the experimental results needed to facilitate the assessment. While there were a good number of candidates who handled the demands of the analysis in **Question 2**, there were many who could have scored more marks if they had consistently followed the instructions.

Comments on specific questions

Question 1

(a) Although most candidates supplied temperature readings for all the experiments, there were a considerable number who did not provide any indication that temperatures were being recorded to the nearest 0.5°C – a single reading to either 0.0 or 0.5 was sufficient to secure the mark. Temperature rises were generally correctly calculated but mistakes were found. There was evidence that some candidates drew graphs based on a few or indeed no results and used them to find their temperature rises. The concentrations of **P** and **Q** requested in the confidential instructions produce an increase in temperature rise for experiments 1 to 3 and a fall for experiments 4 to 7, and this pattern was successfully obtained by most of the candidates. Many of the temperature rises were within 1.0°C of the Supervisor's results and as a result it was not uncommon to find high scores in this part of **Question 1**.

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Test 4 convinced many candidates that **S** had been involved in a redox reaction but those offering an answer in the conclusions were equally split between it being a reducing or an oxidising agent.

CHEMISTRY

Paper 5070/41
Alternative to Practical

Key Messages

Candidates should be aware that the rate of diffusion of gases is related to their molecular masses and densities.

Candidates should be aware that the method by which gases are collected depends on their densities compared to the density of air and also on their solubility in water.

Candidates should know the colours and physical states of common substances used in the laboratory.

In questions involving graphs, candidates should ensure that they use the graph (when instructed) and not the table of results to deduce numerical answers.

General Comments

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

Skills tested include recognition and use of chemical apparatus, reading measurements from diagrams of chemical apparatus, recall of experimental procedures, handling and interpretation of data, drawing of graphs, analysis of unknown salts, and calculations using experimental data.

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

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

Calculations are generally completed accurately using the appropriate significant figures.

Comments on Specific Questions

Question 1

(a) (i) This was answered correctly by the majority of candidates. O was occasionally seen as the formula of oxygen instead of O_2.

(ii) The colour of copper(II) oxide was known by a minority of candidates. Blue was commonly seen.

(b) The majority of candidates gave the correct answer to part **(i)**. In part **(ii)** oxygen was commonly seen, as were water vapour and hydrogen. Copper and copper(II) oxide were occasionally seen. Parts **(iii)** and **(v)** were answered well though part **(iv)** proved more challenging.

(c) This calculation proved challenging for the majority of candidates.

Question 2

(a) The majority of candidates were able to answer parts **(i)** and **(ii)**. Part **(iii)** asks 'How can the pH value… be determined?' which means candidates are being asked how they would measure pH practically. A pH meter or Universal Indicator are the preferred answers. Using the pH scale was a very common answer although is not a method of measurement. Litmus and phenolphthalein were also commonly given as methods by which pH is measured.

(b) The majority of candidates were able to answer parts **(i)** and **(ii)**. Candidates found part **(iii)** more challenging. They should know that lighter molecules diffuse faster than heavier molecules. 'Lighter' and 'heavier' on their own provide insufficient information, although lower density is an acceptable alternative. Lower relative molecular mass is also an acceptable alternative, although not as good as the others, because some substances with lower relative molecular mass are solids or liquids and nor gaseous so do not diffuse as fast.

(c) Very few candidates referred to solubility in water as a reason why **Z** was not chosen as a method of collection for both of the two gases.

Question 3

A very large majority of candidates were able to calculate the empirical formula and therefore gave the correct answer to this multiple choice question.

Question 4

A majority of candidates gave the correct answer to this multiple choice question. The decrease in mass could only have been due to a gas escaping from the reaction mixture, which would only occur in **(b)**.

Question 5

A large majority of candidates realised that magnesium was the most reactive metal, followed by iron and silver respectively, and therefore gave the correct answer to this multiple choice question.

Question 6

Fewer candidates gave the correct answer to this multiple choice question. The 2:1 mole ratio was not always used.

Question 7

A majority of candidates worked through all parts of this titration calculation and achieved the correct final answer. There were no common errors in any of the various sections. A very small number of candidates were unable to read the diagrams of burettes correctly. All three values were occasionally used to calculate the average volume instead of using titration numbers 2 and 3 which have two values which are the closest together.

In the calculations, errors are carried forward so that candidates are given credit for correct chemistry even if an error has been made in an earlier part.

Question 8

Some candidates were unfamiliar with the experimental methods and their results used in this type of analysis. Sections of the table were occasionally left blank.

(a) **H** contains transition metal ions (or cations) is the preferred way to answer this question.

(b) A test and observation giving the result of the test for the gas given off was often stated, although the gas was not always identified (as ammonia).

(c) Reagents which are used when dissolved in water, such as barium chloride and barium nitrate, should be referred to as either aqueous or as solutions rather than merely giving the name of the compound.

Question 9

(a) The colour of silver iodide was known by a minority of candidates.

(b) A very large majority of candidates were able to complete the table correctly.

(c) The graph was usually drawn correctly, although some points were occasionally incorrect, such as 2.25 being plotted three times instead of 2.35.

(d) Parts **(i)**, **(ii)** and **(iii)** were usually answered well, although some candidates used the table instead of the graph to answer the questions. In **(iii)**, 8.0 cm^3 was a common answer from candidates who used the table to answer the question rather than the graph.

(e) The equation was often incorrect. A common error was to give the formula of silver iodide as AgI_2

(f),**(g)** The calculations in these final parts were found to be challenging for the majority of candidates.

CHEMISTRY

Paper 5070/42
Alternative to Practical

Key Messages

When candidates are asked to draw a graph they should take care to follow the instructions given in the stem of the question. Straight lines should be extended, where appropriate, to pass through zero. A ruler should always be used to draw straight lines.

In answering calculations candidates should show all of their working and express their answers to appropriate significant figures.

General Comments

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

Skills tested include recognition and use of chemical apparatus, reading measurements from diagrams of chemical apparatus, recall of experimental procedures, handling and interpretation of data, drawing of graphs, analysis of unknown salts, and calculations using experimental data.

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

Most candidates show competency of plotting points accurately on graphs and in drawing the lines as instructed.

Most calculation parts involve a one stage calculation and are worth one mark. When the number of marks allocated to a calculation is greater than one, it is an indication of its difficulty. In such cases one or more of the marks will be for the working. If no working is shown and the answer is incorrect all the allocated marks for that calculation are lost.

Candidates should always express their answers to a minimum of two significant figures except in titration questions where answers should be given to three significant figures.

Candidates are encouraged to take care in the spelling of chemicals, apparatus and techniques in order to avoid any confusion between, for example, ethanol and ethanal.

Many candidates continue to confuse the test for hydrogen with that of oxygen.

Comments on specific questions.

Question 1

Candidates generally scored well on all parts of this question.

(a) (i) Candidates are advised to name this instrument as a gas syringe although the mark was not lost for omitting the word gas.

(ii) A few candidates read the volume as 10.6 cm^3 rather than 16 cm^3.

(b) (i) Several incorrectly balanced equations were seen and incorrect formulae, particularly that of calcium chloride.

(ii) Several candidates used hydrochloric acid instead of sulfuric acid in the equation and confused the test for hydrogen with that of oxygen. The statement that hydrogen burns with a pop is not sufficient to gain the mark.

Question 2

(a) Off white, cream or pale yellow are acceptable colours for silver bromide.

(b),**(c)**,(**d**) In each of **(c)** and **(d)**, candidates are asked to calculate the mass of silver bromide produced when different numbers of moles of silver nitrate and sodium bromide are added together, first using their answers from **(b)**. It should be recognised that the lower number of moles is the determining factor in calculating the yield of silver bromide. In many cases the higher number of moles was used.

Question 3

(a) Most candidates gave the correct formulae for hexane and heptane.

(b) Very few completed all the apparatus correctly. Errors included: the use of a Bunsen burner, which is not appropriate as the alkanes are flammable; no indication of heating (a water bath or an electric heater is required); a thermometer positioned either too high or too low or not inserted in a cork; the condenser not sloping downwards; no inner tube to the condenser or the water flow not clearly labelled or flowing in the wrong direction; the receiver flask corked rather than open-ended.

Questions 4 - 8

These multiple choice questions were correctly answered by the majority of candidates.

Question 9

This question was generally well answered with most candidates obtaining the majority of the marks.

(a) This part was generally answered correctly.

(b) The correct equation is $ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$

A few candidates suggested that H_2 was formed rather than water.

(c) The correct colour change is red to pink or yellow.

(d) As usual, when errors occur in the burette readings or in subtracting the volumes, the mean must be taken from the two closest titres.

A common error is to use titres 2 and 3 irrespective of the aforementioned errors.

(e) to **(l)** Any error may be carried forward and if used correctly in subsequent parts, may gain marks.

In all cases answers must be correct to minimum of 3 significant figures except when the third figure is zero. This applies to answers as shown on the answer line. Candidates are advised not to round up or down any answer before recording it in the answer line e.g. answer **(l)** is 79.5% and should be given on the answer line as 79.5, not rounded to 79 or 80.

Question 10

Candidates must indicate the initial and final colours to get the marks. In each of the three answers no mark is given for any colour on its own but an answer such as 'goes colourless' can gain the second mark.

(a) Colourless to brown or black, or black or brown from colourless gains the mark.

(b),**(c)** The correct answer to **(b)** is orange to green. This colour change was generally well known, as was **(c)**, purple or pink to colourless, though several cases were seen where the candidate mixed up the tests for dichromate and permanganate.

Question 11

(a) Most candidates scored both marks by reading the thermometer diagrams and completing the table correctly.

(b) Most candidates plotted the points correctly on the grid and connected the points with two intersecting straight lines. This produces a maximum temperature of approximately 9.8^{o}.

However there were two exceptions to this. A few candidates, having plotted the points correctly, then joined points 1 and 3 by a straight line and points 2 and 4 by a straight line the two lines crossing half way up each line. This, of course, did not give a maximum temperature rise as the lines crossed at a temperature much lower than the temperatures of the two solutions before mixing.

Another error occurred when candidates produced two mirror images on the grid. Having drawn a correct graph, a second graph was added by reversing the values for **H** and **J** to produce a mirror image of the first graph.

(c) Answers to these part questions are obtained by reading volumes of **H** and **J** from the graph plotted. Many candidates lost one or marks for failing to ensure that the two volumes of **H** and **J** added up to 100 cm^3.

(d) The number of moles of **J** may be calculated by comparing the number of moles of **J** and **H** in an equation. The correct answer is 0.39 mol/dm^3 but candidates may use the volumes of **J** and **H** taken from their own graph to calculate an alternative answer.

In this question the answer must be accurate to two significant figures.

(e) By diluting the concentration of **J** and **H** to half the initial values candidates should realise that the increase in temperature will be half the initial value but the volumes of **J** and **H** will be the same. This is because the temperature rise is proportional to the number of moles of **J** and **H** reacting together.