

CHEMISTRY

Paper 5070/11
Multiple Choice

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

General comments

Questions 16, 30 and 36 were found to be easy. Questions 6, 7, 8, 21, 33, 34 and 39 were found to be more challenging. There was evidence of guessing in Questions 6, 21, 33 and 34.

Comments on specific questions

The choice of options in the following items shows where candidates who performed less well overall, unless specified, have gaps in their knowledge, skills and/or understanding:

Question 3

Some candidates chose option **D** rather than the key, option **C**. These candidates may have thought of X and Y in terms of familiar examples such as sodium and oxygen or calcium and chlorine. This would then make statement 3 incorrect.

Question 6

This item was answered well by candidates who performed well overall. Other candidates either did not know how to work out the answer or perhaps guessed their answer as all of the options were selected.

Question 7

More candidates chose option **D** rather than the key, option **B**. These candidates may have attempted to balance the charge using the potassium ions with one (rather than three) sulfate ion(s) and ignoring the chromium ion.

Question 8

There was some evidence that better performing candidates chose option **B** rather than the key, option **A**. These candidates did not appreciate that it is possible for elements to have an Ar with a whole number and also to have isotopes.

Question 15

There was some evidence that better performing candidates chose option **D** rather than the key, option **A**. These candidates incorrectly linked larger particle size with an increase in the rate of reaction.

Question 21

There was some evidence of guessing for this question and also some evidence of better performing candidates choosing option **D** rather than the key, option **B**. The two salts in option **D** can be made from the listed reagents. These candidates did not appreciate that these two salts can then be reacted with the original reagents to make two further salts by precipitation reactions to give the key **B**. Option **A** was also chosen by some candidates but includes a salt which cannot be made.

Question 33

There was some evidence of guessing with both options **A** and **C** chosen. There was also some evidence of better performing candidates choosing option **A** rather than the key, **D**. Option **A** was chosen by more candidates than the key. Learning objective 11.5.6 requires candidates to understand how bromine adds across the double carbon-carbon bond. It is clear that this is not well understood by some candidates.

Question 34

There was some evidence of guessing and some evidence that better performing candidates choosing option **D** rather than the key, option **C**. Candidates choosing option **D** had the correct stoichiometry, but did not take into account the oxygen present in the ethanol molecule.

Question 39

Option **D** was chosen by more candidates than the key, option **C**. These candidates ignored the statement, given twice, that the chromatogram was of *coloured* dyes, therefore use of a locating reagent is unnecessary.

CHEMISTRY

Paper 5070/12
Multiple Choice

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

General comments

Questions 3 and 8 were found to be easy. Questions 1, 24, 30, 34, 37 and 40 were found to be more challenging. There was evidence of guessing in Questions 24 and 37.

Comments on specific questions

The choice of distractor in the following items shows where candidates who performed less well overall, unless specified, have gaps in their knowledge, skills and/or understanding:

Question 1

Candidates choosing option D incorrectly thought that gas particles will form 'layers' dependent on the mass of the particles in the gas.

Question 2

More candidates chose option B rather than the key, option D. Candidates incorrectly thought that simple molecules had to be elements and did not consider the simple molecules referenced in the syllabus, such as water and ammonia.

Question 4

More candidates chose option A rather than the key, option D. Candidates only used data on the x-axis.

Question 6

Options **A** and **D** were chosen by over 40% of candidates, including some candidates who performed well overall. They incorrectly thought that aqueous and solid sodium chloride conducts electricity by the movement of electrons.

Question 9

Options **B** and **D** were popular incorrect choices. There was also some evidence of guessing. Perhaps candidates thought this item required them to calculate the formula masses of each compound rather than the quicker route of multiplying the number of moles of the compound by the number of O atoms in the formula.

Question 17

Candidates choosing option **C** correctly identified which experiment was carried out at the higher temperature, but did not correctly link the volumes of P and Q in the graphs to the stoichiometry in the equation.

Question 18

Options **C** and **D** were chosen by over half of candidates. They did not understand that the rate of the forward and reverse reactions is the same at equilibrium.

Question 24

There was evidence of guessing and all in the options were chosen. Candidates did not have a good understanding of LOs 7.3.1–7.3.3, preparation of salts.

Question 30

Option **C** was a popular incorrect response. Metal M would be extracted from its ore by heating with carbon, but the column header is 'possible method of extraction of M from MO'. Candidates need to read the question carefully.

Question 34

Option **B** was chosen by over 40% of candidates, including some candidates who performed well overall. Candidates might not have considered the isomer propyl methanoate.

Question 37

More candidates chose option **C** rather than the key, option **A**. Candidates did not, or could not, deduce the equation for the fermentation reaction for glucose.

Question 40

Options **A** and **B** were chosen by over 70% of candidates, including some candidates who performed well overall. The first statement may have steered candidates towards options **A** and **B**, but they needed to use all the information given to deduce the correct answer, option **D**.

CHEMISTRY

Paper 5070/21 Paper 2 Theory

Key messages

- Candidates need more practice constructing balanced equations and ionic equations.
- Many candidates did not understand the term structural formula.
- Many candidates drew structures containing 5- or 3- valent carbon atoms, 1-valent oxygen atoms and 2-valent nitrogen atoms.
- Candidates need to read questions carefully so that they answer what is being asked e.g. **Question 5 (b)(ii)** where the change was more concentrated acid and **Question 5 (c)** where the question asked for the answer to two significant figures.
- Candidates need practice in drawing accurate reaction pathway diagrams.
- Many candidates did not know the reactions in the blast furnace.
- Good practice is to show working out in calculations such that error carried forward marks can be awarded were available.

General comments

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

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

Candidates found using and understanding chemical terminology quite difficult.

Practical techniques used in salt preparation and identification of an ion proved challenging.

Comments on specific questions

Question 1

- (a) (i) Most candidates chose the correct atom. All of the other responses were seen occasionally.
- (ii) The majority of candidates knew the flame colour of **H**. **D** was the most popular incorrect response.
- (iii) Candidates found this a little challenging. All atoms were seen with **E** and **H** being the most common incorrect responses.
- (iv) Many candidates confused the uses of carbon and chlorine, hence a popular response was **G**.
- (v) Almost all candidates chose the correct atom.
- (b) Almost all candidates deduced the correct numbers of protons and neutrons. A small number reversed the numbers or gave 53 as the number of neutrons.

Question 2

- (a) (i) The meaning of redox was well known with many candidates appreciating that these occurred simultaneously. Oxidation or reduction, gain of oxygen, loss of electrons and citing only reduction were the most common incorrect responses.

- (ii) Candidates found this very challenging. Incorrect responses included repeating the equation by naming the substances involved i.e. iron oxide becomes iron or carbon monoxide becomes carbon dioxide and oxygen removed from iron instead of iron ions. Those that appreciated that CO removed oxygen often did not include it being removed from the iron oxide or that electrons were added to the iron ions.
- (b) The most common errors were a double headed arrow or an upwards arrow for ΔH . Common incorrect responses included endothermic reaction pathways, activation energy arrow from products to the top of the energy hump and imprecise arrows that were either too long or too short.
- (c) The blast furnace was not well known. Many thought that calcium carbonate reacted with the sand or with the impurities and many equations gave silicon dioxide as SiO or SiO₄. A significant number omitted the question.
- (d) The properties of transition elements were quite well known. The most common incorrect responses included they are coloured (rather than their compounds are coloured), more reactive or citing general metallic properties such as malleability, ductility and conduction of electricity which also apply to Group I metals.
- (e) (i) Candidates found this difficult. Many thought the equilibrium moved to the left. Those that appreciated the equilibrium moved to the right often omitted gas in their explanation.
(ii) Candidates found this very challenging and a significant number omitted the question. Those that considered the equilibrium discussed decreasing the pressure, not appreciating that an equilibrium would still exist and so pure iron would still not be obtained. The most successful responses realised that the system needed to be open; very few went on to explain that the equilibrium would then be driven completely to the right.
- (f) Candidates found this extremely challenging. Common errors included Fe₃SO₄, FeSO₄, FeS, FeSO, Fe and FeO. Those that gave the correct formulae often did not balance the equation.

Question 3

- (a) Candidates found this quite difficult with many labelling the test-tube or the positive symbol on the power supply. Many omitted the question.
- (b) Many candidates discussed electrons rather than ions or delocalised ions rather than mobile ions.
- (c) (i) Over half of candidates knew the correct product. Sodium and H⁺ were the most common incorrect responses.
(ii) Candidates found this quite challenging. Common incorrect responses included adding the electrons to the chloride ion, $Cl^- \rightarrow Cl + e^-$, $Cl^- + e^- \rightarrow Cl$ and ionising a chlorine molecule.
- (d) The property of graphite was quite well known. Common incorrect responses included low melting point, low boiling point, hard, giant structure, contains delocalised electrons and conducts electricity.
- (e) Over half of candidates named the product correctly. Hydrogen was the most common incorrect response; oxygen, chlorine and sodium hydroxide were also quite common.

Question 4

- (a) About half of the candidates could name one characteristic with a third naming two. Same physical properties, same molecular formula, same chemical formula and repetition of the characteristics in the stem were common incorrect responses.
- (b) (i) Almost all candidates gave a correct explanation. A small number of incorrect responses were seen, including not all the bonds used and does not contain a full amount of hydrogen.

- (ii) Candidates found this a little challenging as structural formula was not well understood. C_4H_8 was the most common incorrect response.
- (iii) Candidates found drawing a displayed formula quite difficult. The most common incorrect responses included 3- and 5- valent carbon atoms; many did not include a double carbon-carbon bond.
- (c) (i) The use of kerosine was well known. Use as a fuel and use in aircraft/jets were both insufficient on their own. A small number of uses of other fractions were seen including cooking gas, lubricant and road surfacing.
- (ii) Candidates found this quite challenging and often gave an incorrect formula for at least one of the products. Those that gave correct products often did not balance the equation. A small number omitted the question.
- (d) (i) Many candidates appreciated the product to be HCl but gave the name incorrectly as hydrochloric acid rather than hydrogen chloride. Hydrogen was also a common incorrect response.
- (ii) Ultraviolet light was quite well known. Incorrect responses included high pressure, catalyst (often named), constant temperature and absence of oxygen.
- (e) (i) Most candidates performed well. Common errors included not breaking the $C=C$ double bond, miscounting the number of $C-H$ bonds both broken and made and the most common error being reversing the final subtraction.
- (ii) The colour change was quite well known. The most common error was reversing the colour change.

Question 5

- (a) State symbols were well known. Solid for copper chloride was the most common incorrect response; aqueous for water was also seen.
- (b) (i) Many candidates showed either a steeper curve or the same final mass. Incorrect responses included lines above the one on the paper and often drawn as a straight line from 200.0 g to 6 minutes, or a line ending at a lower mass.
- (ii) Many candidates misread the original experiment which added large pieces of copper(II) carbonate to the acid. Hence, they assumed the large pieces of copper(II) carbonate was the change and so discussed the effects of surface area rather than the increased acid concentration. Those that did appreciate that concentration had been increased discussed more particles rather than more crowded particles and more collisions rather than increased frequency of collision.
- (c) Many candidates calculated the volume correctly but then did not give their answer to two significant figures. Common errors included not using the stoichiometry in the equation and using 0.5 as the number of moles of acid rather than its concentration. Those that did not use the stoichiometry often also did not give their answer to two significant figures.
- (d) (i) The test for copper(II) ions with aqueous ammonia was not well known. White, green and cream precipitates and colourless solution were often seen for the first part and insoluble for the second part.
- (ii) Candidates found this quite difficult. The most common responses were 2 and +2. Other incorrect responses included 0, -1, 1 and +3.
- (e) Candidates continue to find describing salt preparations difficult. Many did not appreciate that an acid and alkali were reacting in solution and so did not use titration. The small number that did titrate the solutions did not repeat the mixing with the titration volumes but without the indicator. Many thought one of the reagents was solid and so filtered to obtain the solution of ammonium chloride. Some candidates then gained partial credit by evaporating the solution to saturation, cooling and drying. Many incorrectly heated or evaporated to dryness. A small number thought incorrectly that the product was a precipitate and so filtered washed and dried.

Question 6

- (a) (i) Whilst many candidates discussed electrons, the majority discussed no free or delocalised electrons which were not creditworthy unless their lack of movement was also mentioned.
- (ii) Many candidates gave a correct property. Incorrect responses included coloured compounds, strong and a discussion of its bonding and structure.
- (b) Intermolecular forces were not well known. Few bonds, weak bonds and weak covalent bonds were popular incorrect responses. Some answers showed poor use of terminology such as weak intermolecular forces between atoms. Simple covalent was insufficient.
- (c) Most candidates drew a correct dot and cross diagram for disulfur dichloride
- (d) The majority of candidates calculated either the number of moles of disulfur dichloride or the number of moles of water. A significant number calculated both. The more successful candidates used the stoichiometry of the equation to show water being in excess. Some candidates did not calculate moles but compared the masses and so gained no credit.
- (e) (i) Acid rain, respiratory issues or irritation were well known. Non-creditworthy responses included climate change, greenhouse gas, toxic and disease causing. Depletion of ozone was incorrect.
- (ii) Candidates found this challenging. Incorrect responses included: plant more trees, reduce livestock, use a catalytic converter, use filters, do not burn sulfur, more efficient engines and less factories or factory waste.

Question 7

- (a) (i) Naming the ester was quite well known. The most common incorrect response was propyl methanoate. Alcohols and acids were also quite popular.
- Candidates found drawing the ester more difficult. Many drew an acid, had $-O$ at the end of the molecule, had a 5-valent carbon atom, had an alcohol and a ketone group or just an alcohol.
- (ii) Both parts were quite well known. The first part was better known; incorrect responses included reversible reaction, receiving protons and electron donor. For the second part, fully ionised and partially dissolved were common responses.
- (iii) Candidates deduced the products quite well; hydrogen was very well known. Common incorrect responses included salt, magnesium oxide, water, propanol and ethanol.
- (iv) The particulate structure of a solid was well known. For movement, non-creditworthy responses included slow, no movement and fixed.
- For separation, non-creditworthy responses included closer, fixed, small and a description of being heated. A small number described how the particles could be separated.
- (b) (i) Candidates found this very difficult and a significant number omitted the question. The linkages often had an extra O or H in them sometimes with 5-valent carbon atoms, 1-valent oxygen atoms and 2-valent nitrogen atoms; each contained totally different atoms or the boxes had a + between them. The ends of the molecule occasionally had continuation bonds.
- (ii) Polymer was not well defined. In place of large molecule, common non-creditworthy responses included a molecule, a substance and a polymer. In place of 'many monomers', a large number of responses referred to 'making from one or more monomers' or 'from monomers'. A significant number described the breakdown of a polymer rather than polymerisation.
- (iii) The difference between polymerisations was quite well known. Non-creditworthy responses included condensation polymers react with water, condensation polymers have a double bond, addition polymers have a double bond, addition polymers use only one monomer, addition polymer has ester or amide linkages and condensation polymers are natural.

CHEMISTRY

Paper 5070/22 Theory

Key messages

- Candidates found aspects of polymers and polymerisation quite challenging, in particular drawing a polymer.
- Candidates must use the names of particles with clarity so that it is clear within an answer if the particle involved is an atom, molecule or ion.
- Candidates found aspects of organic chemistry demanding and were often unable to name or draw the correct organic products of a reaction. In particular, candidates did not always know how to draw the ester linkage.
- Candidates need to check that blank spaces within the question paper are actually spaces and not the answer spaces where either calculations, drawings or labels should be written.

General comments

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

In quantitative questions, some candidates did not always show sufficient working out so it was not always possible to award error carried forward marks.

Candidates often found balancing equation difficult often because they wrote down incorrect formulae so making the balancing impossible.

Comments on specific questions

Question 1

This question was about the atomic structure of some elements.

- (a) Most candidates followed the rubric and gave the letter of the electronic configuration rather than the symbol or name of the element.
- (i) Most candidates identified the noble gas.
- (ii) Most candidates identified the electronic configuration for aluminium.
- (iii) Many candidates identified the element in Group V of the Periodic Table.
- (iv) Many candidates identified the element in Period 3 of the Periodic Table.
- (v) Many candidates were able to identify the correct element.
- (b) Most candidates deduced the number of protons and the number of neutrons. The most common misconception was to give the number of neutrons as 51.

Question 2

This question was about iron.

- (a) (i) Many candidates did not associate burning carbon with the release of thermal energy to maintain the temperature within the blast furnace. The most common misconception was to produce carbon monoxide.
- (ii) Many candidates were able to state one adverse effect of carbon monoxide. The most common answers referred to carbon monoxide being toxic or poisonous. Some candidates tried to explain why carbon monoxide is poisonous in terms of its effect on the oxygen carrying capacity of blood. Some candidates did not mention blood and merely referred to reduced oxygen transport within the body. This was not considered to be sufficient to be awarded credit. Another misconception was that carbon monoxide causes global warming. A common answer was that carbon monoxide caused respiratory or breathing problems without specifying why.
- (iii) Candidates often did not balance the equation. Other candidates did not appreciate that carbon dioxide was the second product of the reaction.
- (b) The best answers gave two equations, either symbol or word equations, describing the thermal decomposition of calcium carbonate and the reaction of calcium oxide with silicon(IV) oxide. A common misconception was that calcium carbonate itself reacts with silicon(IV) oxide to form slag. Other candidates did not appreciate that slag is formed rather than removed by calcium oxide. A significant proportion of candidates did not answer this question.
- (c) Candidates were often able to state two suitable properties. The most common properties were that transition elements were often catalysts, have variable oxidation numbers, form coloured compounds, are hard and have a high density. Only a small proportion of the candidates gave a difference in chemical properties such as Group I elements are more reactive.
- (d) Some candidates only explained one method of rust protection and this was often sacrificial protection. For sacrificial protection, although many answers stated that zinc was more reactive than iron, they did not explain that zinc reacts, instead of iron, with water and oxygen. A common misconception was that zinc rusts rather than zinc corrodes. When explaining the barrier method, many candidates did not specify that the barrier does not allow contact between oxygen and water.
- (e) A significant proportion of the candidates predicted that the position of equilibrium changed and did not appreciate the number of moles of gaseous reactants equals the number of moles of gaseous products.
- (f) Candidates found this question very challenging. The formula of iron(II) chloride and iron(III) chloride were often incorrect and as a result the equation could not be balanced. Typical incorrect formulae included Fe_2Cl and Fe_2Cl_3 . Many candidates identified the third product as water.

Question 3

This question was about the electrolysis of dilute sulfuric acid.

- (a) Many candidates were not able to recall the definition for the term electrolysis. Only the best answers appreciated that electrolysis involves the decomposition of an aqueous or molten ionic compound using electricity. Typical answers did not mention ionic compounds in their answers.
- (b) A significant proportion of candidates did not answer this question. Common misconceptions involved labelling the test-tube or the sulfuric acid in the test-tube.
- (c) (i) Many candidates gave hydrogen as the product. Some gave oxygen and others sulfur dioxide.
- (ii) Many candidates could not construct the correct ionic half-equation. Some candidates wrote the equation the wrong way around; others used oxide ions losing electrons rather than hydroxide ions. Electrons were often missing or on the incorrect side of the equation. A significant proportion of candidates did not answer this question.
- (d) Candidates gave a variety of names of elements, many of which were metals that react with dilute sulfuric acid. Carbon was also a common incorrect answer. Some candidates did choose a suitable element such as platinum.

Question 4

This question was about alkanes and alkenes.

- (a) Many candidates stated two correct characteristics of a homologous series. The most common characteristics were the same chemical properties or physical properties that showed an observable trend. The physical property trend was often given as a specific example such as the boiling points increased down a homologous series.
- (b) (i) Many candidates recognised the significance of butane having single carbon-carbon bonds but often forgot to mention that all these carbon-carbon bonds were single bonds. Candidates were more likely to mention that butane does not have any double bonds, which earned full credit.
- (ii) Many candidates gave the molecular formula C_4H_{10} rather than the structural formula $CH_3CH_2CH_2CH_3$.
- (c) (i) A common misconception was to refer to a feedstock for animals rather than for the chemical industry. Other incorrect uses included fuels for ships and aeroplanes.
- (ii) Candidates found this question challenging because they often did not write the correct formula for propane or ethene, or included other hydrocarbons as products. Some candidates gave extra reactants in addition to nonane. A significant proportion of candidates did not answer this question.
- (d) (i) Many candidates recognised that the reaction was an example of substitution. Some candidates referred to chlorination and this was also given credit. Other candidates referred to displacement but this was not credited.
- (ii) Candidates often gave imprecise answers that referred to the ultraviolet light providing energy but they did not refer to either providing the activation energy or the energy needed to break the chlorine-chlorine bond.
- (iii) The best answers gave the correct answer of -122 kJ/mol supported by clear working out. The working out allowed the award of error carried forward marks and was best organised as:
- Bond broken with the associated energy change.
 - Bond formed with the associated energy change.
 - Enthalpy change being the difference between these two energy changes (energy to break bonds minus the energy to form bonds).
- A significant proportion of candidates did not answer this question.
- (e) Candidates often used the explanation that reactants were added to describe an addition reaction rather than appreciating that there was only one product or that no other molecule was lost in the reaction.

Question 5

This question was about the reaction between zinc and dilute hydrochloric acid.

- (a) Many candidates wrote the correct state symbols. A common error was to have the zinc chloride as a solid or a liquid. Some candidates wrote the state symbols in upper case rather than lower case.
- (b) (i) The best answers appreciated that the slope or gradient of the graph decreases with time. Descriptions of the line for example curving until it becomes straight were not sufficient for the award of credit.

- (ii) Many candidates referred to changes in the kinetic energy or speed of the particle, which was not relevant since there was no change in temperature. The best answers appreciated that during the reaction the concentration of the hydrochloric acid decreased and then gave explanations that related to particle collisions. These answers appreciated that as time increased the particles became less crowded and the collision frequency decreased.
- (iii) As in (ii), many candidates referred to the kinetic energy of the particles and the speed of particles and did not mention the increase in surface area when powdered zinc is used. The best answers appreciated that the collision frequency between particles increased and there were more exposed particles on the surface of the zinc.
- (c) A significant proportion of the candidates calculated the correct volume of hydrogen gas although some of these candidates quoted the answer to three significant figures rather than two significant figures. The best answers worked out the number of moles of hydrochloric acid, used this to work out the number of moles of hydrogen and finally used the molar volume of hydrogen to calculate the volume of hydrogen. Some candidates did not use the stoichiometric equation to use the correct link between number of moles of hydrochloric acid with the number of moles of hydrogen.
- (d) Many candidates were not awarded full credit since the two energy changes on their diagrams were not sufficiently clear. Candidates should be advised to use an arrowhead on the energy change lines making sure the arrowhead is in the correct direction and start the line from the correct energy level. Double headed arrows should be avoided since they do not show the direction of the energy change.

Some candidates muddled up the position of the reactants and products both in terms of height and horizontal position in the diagram.

- (e) Some candidates recalled the correct observations for aqueous zinc ions. The appearance of a white precipitate was the most common observation but some candidates did not appreciate that the precipitate dissolves in excess aqueous ammonia to give a colourless solution.
- (f) Candidates found this question quite challenging and often these candidates focused on making the aqueous zinc chloride rather than how crystals were made from the aqueous zinc chloride. Answers often mentioned filtering but it was unclear if this was filtering off excess zinc or filtering off crystals of zinc chloride. In the same way, candidates often described heating to get a saturated solution without specifying what was being heated the reaction mixture or the filtrate after filtering.

The best answers described:

- filtering the reaction mixture to get aqueous zinc chloride
- heating the aqueous zinc chloride to get a saturated solution
- cooling the saturated solution to get crystals and drying the crystals with filter paper.

A significant proportion of the candidates heated the filtrate to dryness; this was not given any credit.

Question 6

This question was about boron nitride and hydrazine.

- (a) The idea that boron nitride has a giant structure was well known although some candidates thought that it was an ionic compound rather than a covalent compound. Candidates often mentioned strong bonds, but other candidates mentioned strong bonds between bonds or between molecules. A common misconception was to refer to intermolecular forces.
- (b) Many candidates referred to a lack of mobile electrons, although some candidates just referred to a simple molecular structure.
- (c) Candidates found drawing the dot-and-cross diagram very challenging. Common misconceptions included drawing a double or triple bond between the nitrogen atoms, having no lone pairs on the nitrogen atoms or including extra electrons around the hydrogen atoms.

- (d)(i) Some candidates could deduce the oxidation number of nitrogen in ammonia. Some of these candidates also showed their working out even though this was not needed.
- (ii) Candidates often ignored the instruction in the question and referred to electron gain or electron loss. Other candidates only explained there was either no oxidation or no reduction. Only the best answers appreciated that the oxidation number of nitrogen did not change during the reaction.
- (e) Candidates used a variety of different methods to show that boron oxide was in excess. Most of the approaches involved some or all of these four steps:
- calculating the number of moles of boron oxide
 - calculating the number of moles of magnesium
 - using the stoichiometric relationship between moles of boron oxide and moles of magnesium
 - comparing moles or mass needed with actual moles or mass.

The best answers showed working out rather than just a set of unrelated calculations. Some candidates calculated the mass of boron oxide that reacts with the provided magnesium to show that some boron oxide would remain unreacted. Other candidates calculated the mass of magnesium needed to react with the provided boron oxide to show there was not enough magnesium.

Question 7

This question was about esters and polyesters.

- (a)(i) Some candidates recognised that the formula shown was a general formula.
- (ii) Only a small proportion of the candidates deduced that the value of n was 5. Numbers between 1 to 4 were also common incorrect answers. Some candidates gave the formula of the ester with $n = 5$ and this was given full credit.
- (b) Many candidates attempted to draw a displayed formula but a significant proportion of the candidates did not draw an ester. Only a small proportion of candidates drew butyl ethanoate.
- (c)(i) Many candidates found this question challenging because they could not draw the ester linkage between repeat units. The ester linkage often included extra carbon, hydrogen or oxygen atoms. Most candidates did not draw the correct continuation bonds at both ends of the structure.
- (ii) Candidates often named condensation polymerisation.
- (d) Candidates found this question challenging and often described recycling and the use of physical processes. The idea of cracking or thermal decomposition of polymers to make monomers and subsequent repolymerisation was rarely mentioned in answers. A significant proportion of the candidates did not answer this question.
- (e)(i) Candidates were often able to name at least two products of the reaction; water and carbon dioxide were the most likely correct answers. Some candidates named sodium ethanoate as just 'salt'.
- (ii) Candidates often described the separation of particles in a liquid as well as the arrangement. Comments about the separation of particles were ignored. Answers often referred to a random arrangement or a disordered arrangement. In terms of the motion, the best answers referred to particles sliding over each other. Random motion was also accepted. It was not sufficient just to refer to the particles being free to move.

CHEMISTRY

Paper 5070/31 Practical Test

Key messages

- Candidates should lay out their workings for calculation questions clearly, with indications of what is being calculated at each stage. By working in this way, candidates may be eligible to get an 'error carried forward' mark from a question, even when they have made an error.
- Candidates should note that a solid disappearing is as valid an observation as bubbles appearing. They should also make sure that when formulae are written that they are correct.
- While most candidates gave a successful method for the planning question, some missed out the accuracy section and should be sure that they carefully read and respond to the whole of the question stem.

General comments

In most cases, candidates were well practised in carrying out the titration practical and in performing calculations with their determined volume. A common area that could be improved was the reading and understanding of the question stem. There were instances when taking a bit more time reading the question first would have benefitted candidates. This was relevant in **Question 1(e)** when candidates were asked to give their answer to three significant figures, and in **Question 3** when asked to discuss the accuracy of their method.

Comments on specific questions

Question 1

- (a) Successful candidates carefully carried out four titrations, giving initial and final burette readings to one decimal place and then correctly calculated the volume of **X** used. The highest achieving candidates obtained at least one volume that was within 0.2 cm^3 of the Supervisor's average volume. Candidates who were slightly less accurate, but still had a volume which was within 0.3 cm^3 of the Supervisor's average volume, still got some credit for their accuracy.
- (b) Candidates were required to tick the 'best two' titration results from Table 1.1 and to explain their choice. Most candidates correctly chose their closest two values and explained this in the answer. Some candidates seemed to not understand that the 'best' values meant those that were closest together and instead ticked which ones used the least ethanedioic acid.
- (c) In this question candidates were required to use their ticked values to calculate the average volume of ethanedioic acid needed. Some candidates calculated an average of all the values, rather than just their ticked values.
- (d) Candidates were asked to calculate the number of moles of sodium hydroxide, **Y**, in this question. All the information required (the volume and concentration of NaOH(aq)) was given in the question. Many candidates gave the correct answer of 0.02 moles.

- (e) The question stem told the candidates, 'One mole of ethanedioic acid is neutralised by two moles of sodium hydroxide' and asked them to use their answers to (c) and (d) to calculate the concentration of ethanedioic acid. Successful candidates used the ratio provided to recognise that they would need to halve the number of moles that they calculated for NaOH, so they divided their answer from (d) by 2. They then divided that answer by their average volume from (c) in dm^3 . The question stem also asked that candidates, 'Give your answer to three significant figures'. Several candidates did not give their answer to three significant figures, even though they had done the calculation correctly. Candidates should be reminded to follow the guidance of the question stem, as they will not achieve full credit if they do not give answers to the precision requested.
- (f) (i) Candidates were given the formula of ethanedioic acid and the mass of ethanedioic acid (6.3 g) in 100 cm^3 of the aqueous solution. They were asked to calculate the relative formula mass of ethanedioic acid using their answer from (e). There were various acceptable methods to get this answer. One correct method, which some successful candidates used, was to multiply their answer of the concentration from (e) by 0.1, giving the number of moles in 100 cm^3 . They then divided the mass, 6.3 g, by this number of moles to give the relative molecular mass. Candidates who incorrectly calculated the number of moles in the first step were still able to receive an error carried forward mark, if they clearly indicated that they were dividing 6.3 g by their number of moles. Candidates should be encouraged to lay out their answers to calculations clearly, indicating what the calculated values refer to e.g. number of moles, mass, concentration etc. so that error carried forward marks are accessible.
- (ii) Using their answer to (f)(i) candidates were asked to deduce the value of n (the number of moles of water in the formula of the hydrated compound). Successful candidates calculated the M_r of $\text{C}_2\text{H}_2\text{O}_4$ then subtracted this value from their answer to (f)(i). This gave an intermediate value which was divided by 18 (the M_r of H_2O) to give the final answer.
- (g) Candidates were asked why the conical flask in the titration is placed on a white tile. Many candidates correctly stated that it is to see the colour change more clearly. It should be noted that all three parts of this statement were needed. Some candidates just mentioned seeing the colour, but the important part of a titration is the endpoint, when the colour changes. Others omitted the colour and just said 'the change' but they needed to say what type of change they were looking for. Finally, some did mention the colour change, but did not say how the white tile would help. The colour change would be visible without the tile, the key point is that the colour change could be seen more easily, or more clearly.
- (h) Most candidates successfully stated that a measuring cylinder is not used in this experiment because it is not accurate, or not precise enough.

Question 2

In (a), (b) and (c), candidates were asked to carry out tests on solid **P**. They were instructed to record observations, test and identify any gases evolved and to describe the gas tests used.

- (a) This involved the candidates adding dilute hydrochloric acid to a sample of **P** in a boiling tube. Most candidates successfully noted that there was effervescence and that when the gas was tested by bubbling it through limewater. The limewater became cloudy indicating the presence of carbon dioxide. The better performing candidates also recognised that the solid had disappeared.
- (b) (i) To one half of the mixture from (a) candidates were asked to add aqueous sodium hydroxide drop by drop, then in excess. Most candidates were able to identify that a white precipitate was formed, which was soluble in excess. Some candidates also correctly noted that it left a colourless solution.
- (ii) Candidates were asked to add aqueous ammonia drop by drop and then in excess. Most candidates correctly identified a white precipitate which was soluble in excess.
- (c) Most candidates correctly identified the cation and anion in solid **P** as zinc and carbonate. Candidates should be reminded to make full use of the 'Notes for use in qualitative analysis' at the back of the paper. They should also be reminded that if formulae are written then they must be correct. This question just asked candidates to 'identify' the ions, so a name was perfectly acceptable. If a candidate did write formulae, they could check them in the 'Notes for use in qualitative analysis'.

- (d) Candidates were asked to carry out a flame test on solution **Q**. They should have noted that there was a lilac flame.
- (e) (i) Candidates were instructed to add nitric acid to solution **Q** in a test-tube. Most candidates were successful in recognising that there was no observable change.
- (ii) To the test-tube from (e)(i), candidates were asked to add aqueous silver nitrate and to record their observations. Most candidates were successful in this question and recorded a yellow precipitate.
- (f) Most candidates correctly identified the cation and anion in solution **Q** as potassium and iodide. Candidates should be reminded to make full use of the 'Notes for use in qualitative analysis' at the back of the paper. They should also be reminded that if formulae are written then they must be correct. This question just asked candidates to 'identify' the ions, so a name was perfectly acceptable. If a candidate did write formulae, they could check them in the 'Notes for use in qualitative analysis'.

Question 3

In the question stem, candidates were told that argentan is an alloy containing zinc, nickel and copper. They were told that zinc and nickel react with dilute hydrochloric acid, but that copper does not. Using this information, they were asked to plan an investigation to find the percentage by mass of copper in a powdered sample of argentan.

Although most candidates answered this question to a high level, some candidates did not appreciate that the zinc, nickel and copper were in an alloy and described a method as if they were using three separate powders.

Candidates were asked to consider the apparatus needed, the methods and measurements, accuracy and the calculation.

Apparatus: Better performing candidates not only gave a suitable piece of apparatus to use for their reaction, e.g. beaker or conical flask but also clearly stated that they would carry out their reaction in it. If the apparatus was simply listed, but its use not described, then the candidates did not get credit for the 'apparatus' section.

Method to use and measurements to take: The best responses described how to weigh the argentan sample, add hydrochloric acid to the sample, filter the unreacted copper and then re-weigh the copper. Some candidates missed out the initial weighing step, or when filtering they stated they were removing the zinc and nickel.

Accuracy: Better performing candidates described that hydrochloric acid should be in excess, or that the reaction should continue until effervescence ends. They described washing and drying the copper after filtering it and recognised that they should repeat the investigation and calculate an average. Of the four bullet points, the accuracy statement was the one that was most frequently missed out. Candidates should be advised to re-read their answer and consider if they have met all the bullet points. Successful candidates made rough notes next to the question stem, so they did not forget to cover any of the required areas.

Calculation: Most candidates successfully gave an acceptable calculation to obtain the percentage by mass of copper in argentan.

CHEMISTRY

Paper 5070/32 Practical Test

Key messages

It is crucial that candidates have as much practical experience as possible before doing a practical examination. Practice at titrations improves candidates' accuracy and practicing the flame test makes candidates familiar with the colours seen. Doing experiments with coloured solutions helps candidates identify the colours of precipitates formed.

Comments on specific questions

Question 1

Candidates generally found **(d)–(f)** difficult. Some candidates omitted one or more of these parts.

- (a)** Most candidates were able to do four titrations and record their results. A significant number of candidates did not show all figures to one decimal place, particularly when the value is 0.0. The accuracy of titration results was quite variable with some candidates being a long way from the Supervisor values. It is important that appropriate Supervisor values are provided as the accuracy of candidates' titrations are marked with reference to these.
- (b)** There were a wide range of answers to this part with some ticks appearing in apparently random places. However, many candidates recognised that they needed to select the two values that were identical, within 0.2 cm^3 of each other or the two closest values. Some candidates did not follow the instructions correctly and ticked either one value or more than two values.
- (c)** Most candidates could calculate a correct average of their ticked values. Some candidates calculated an average of all four values.
- (d)** A common error was to use the value of 24 or 24000 in the calculation, presumably because they were thinking of the volume of one mole of gas at room temperature and pressure. Another common error was to try to use an M_r or A_r value.
- (e)** Very few candidates achieved full credit. Some candidates multiplied their answer to **(d)** by two instead of dividing by two from the molar ratio in the equation. Candidates who obtained a correct answer from their data sometimes did not express it to three significant figures as was specifically required in the question. This was particularly the case when the candidate's answer came to a value where the second or third significant figure was a 0. Candidates were awarded partial credit if they did an incorrect calculation but expressed their answer correctly to three significant figures.
- (f)** This question was more difficult because less structure was given to the calculation and candidates needed to do a three-step calculation to gain full credit. Many candidates correctly determined the molar mass but then did not know how to use it in the rest of the calculation. The mark scheme shows one method for the calculation, but credit was given for any correct method.
- (g)** Many candidates correctly described the idea of needing to mix the contents
- (h)** Many candidates realised that this increased the accuracy of the titration by avoiding overshooting the end-point. The most common error was to write about the ease of seeing the colour change.

Question 2

- (a) It is important that candidates gain experience in doing flame tests and recognising the colours rather than simply using the quantitative analysis notes. In particular, they need to be able to distinguish between the yellow of sodium, the flame colour of calcium which, in practice, is much more red than orange and the very distinct red obtained from lithium ions.

It is essential that an appropriate piece of apparatus that produces a pale blue/colourless flame is provided for this test. A spirit burner is not suitable.

Many candidates described the colour as orange.

- (b) Error carried forward was applied to this part and candidates were given credit for choosing a suitable ion based on their observation of the colour. Equally, if they had written sodium but had not obtained a yellow colour for the flame test then sodium ions would not gain credit.

This general principle is applied throughout **Question 2**.

- (c) Most candidates were able to do this test correctly although many did not describe their observations fully. Some candidates thought they had identified carbon dioxide as the gas evolved.
- (d) Those candidates who had obtained suitable results were generally able to identify the anion, although some thought it was ammonium or ammonia.
- (e) Many candidates answered this by referring to the difficulty of identifying a gas by its smell rather than addressing the hazards associated with this method.
- (f) Most candidates obtained a green precipitate, although some described it as white. Candidates need to be aware that it sometimes requires a large quantity of sodium hydroxide to be sure that excess has been added. With the chromium ion, the precipitate should have dissolved quite easily. Many candidates did not describe the green solution formed when the precipitate dissolved.
- (g) This was generally done well, although as in (e) some candidates thought the precipitate was white.
- (h) Most candidates realised there was no change when nitric acid was added.

Observing a white precipitate in a green solution is difficult. Candidates should be encouraged to always leave a precipitate to stand for a few minutes before recording their observations so that the precipitate settles. This makes it easier to see the colour. Given the nature of the test, candidates should have known that if a precipitate is formed, it is likely to be either white, cream or pale yellow.

The most common error was to state that the precipitate was green.

- (i) The expected answers were chromium(III) and chloride, but award of credit was dependent on the observation candidates had made. Conclusions should always be based on experimental observations.

Question 3

Candidates continue to find the planning question quite difficult. The quality of the answers was very variable. Most candidates made an attempt at an answer, but many did not address all of the bullet points in the question. Candidates cannot gain full credit unless they write about all of these points.

Some candidates misunderstood the question and thought they had been provided with separate samples of zinc and copper.

Some candidates did not gain credit because they described a completely inappropriate method such as distillation or using a magnet. Some candidates suggested electrolysis as a method and gained some credit. Using a method which involved collecting and measuring the volume of hydrogen gas was completely acceptable but few of the candidates who chose this method were able to describe it appropriately or knew how to use the data to obtain the percentage of zinc.

Cambridge Ordinary Level
5070 Chemistry November 2024
Principal Examiner Report for Teachers

Those candidates who described an appropriate method often did not write about techniques that ensured accuracy and/or did not show how to use the data they collected to calculate the percentage of zinc. Calculation of the percentage of copper instead of zinc was quite common.

A very common mistake was for candidates to add the acid to the Muntz, filter the mixture but then go on to suggest that if they evaporated the filtrate they would then obtain zinc crystals.

CHEMISTRY

Paper 5070/41 Alternative to Practical

Key messages

- Candidates should be encouraged to pay attention to the command word used in questions. For example, **Question 1** included a 'describe' command word, which was not always recognised by candidates.
- Candidates should lay out their workings for calculation questions clearly, with indications of what is being calculated at each stage. By working in this way, candidates may be eligible to get an 'error carried forward' mark, even when they have made an error.
- Candidates could have increased their marks on **Question 3** by careful reading of the question stem, or of the 'Notes for use in qualitative analysis'.
- While most candidates gave a successful method for the planning question, some missed out the accuracy section and ensure they carefully read the whole of the question stem.

General comments

Candidates showed much greater awareness of the use of 'Notes for use in qualitative analysis' this year than in previous examination series. The questions which involved referencing those sheets were generally well answered. It was more noticeable this year that questions which involved candidates reflecting on practical techniques that they should be familiar with, such as how to read the scale on a burette, or how to carry out a flame test were less successfully answered for many of the candidates. It was evident in **Question 1** that candidates remembered to give burette readings to one decimal place. A common area that could be improved was the reading and understanding of the question stem. There were instances when taking a bit more time reading the question first would have benefitted the candidates. This was relevant in **Question 1(b)** when asked to 'describe the products', **Question 2(e)** when candidates were asked to give their answer to three significant figures, and in **Question 4** when asked to discuss the accuracy of their method.

Comments on specific questions

Question 1

- (a) Most candidates recognised that the apparatus labelled **L** and **M** were electrodes and that a suitable material from which they are made is carbon or graphite. Some candidates recommended the use of a non-inert metal, which would not be suitable.
- (b) Candidates should be encouraged to take time to understand what the question stem is asking for. The candidates were asked to, 'Describe the appearance of the products at **L** and **M**'. A number of candidates named the products of lead and bromine, but did not describe their appearance. A suitable answer would have been to describe a shiny, grey solid or liquid (due to the molten state of the lead) at the cathode and an orange-brown gas at the anode.

- (c) This question asked candidates to, 'Explain why the lamp goes out' when the teacher stops heating and allows the lead(II) bromide to cool. Successful candidates realised that the molten lead(II) bromide would solidify as it cooled. The best answers also explained that current would no longer flow because ions in the lead(II) bromide would no longer be able to move. Two common misconceptions were evident in the answers of candidates. Some candidates thought that the power for the lamp was coming from heating, rather than from the power supply. Another common misconception was that electrons were no longer able to move in the solidified lead(II) bromide, rather than ions.

Question 2

- (a) Candidates should have completed initial and final burette readings on the table, by using the burette readings shown in Fig. 2.1. They should then have used those readings to give the volumes of ethanedioic acid added, 20.9 cm^3 , 20.5 cm^3 and 19.9 cm^3 . Most candidates gave the correct values for initial and final readings, although there were some who were reading the burette values from the bottom upwards, rather than from the top down, for example giving a reading of 22.9 cm^3 rather than 21.1 cm^3 for the final reading of titration 1. It would be very useful for candidates to have regular practise of reading burette scales, either physically, or using diagrams as were used in this question. Candidates should also be reminded that they need to take guidance for how many decimal places to use from what is already shown on the table. In this case, the values on the table were to one decimal place, so candidates should have given their values to one decimal place also. This includes writing 0.0 cm^3 rather than 0 cm^3 . Most candidates successfully calculated the volumes used based on their values.
- (b) Candidates were required to tick the 'best two' titration results from Table 2.1, which they had completed in (a). Some candidates seemed to not understand that the 'best' values meant those that were closest together. The correct answer was to tick titrations 3 and 4 as their values were the closest, only 0.2 cm^3 apart.
- (c) In this question, candidates were required to use their ticked values to calculate the average volume of ethanedioic acid needed. Some candidates calculated an average of all the values, rather than just their ticked values. The expected answer was 20.0 cm^3 .
- (d) Candidates were asked to calculate the number of moles of sodium hydroxide in this question. All the information required (the volume and concentration of NaOH(aq)) was given in the question. Many candidates gave the correct answer of 0.02 moles.
- (e) The question stem told the candidates, 'One mole of ethanedioic acid is neutralised by two moles of sodium hydroxide' and asked them to use their answers to (c) and (d) to calculate the concentration of ethanedioic acid. Successful candidates used the ratio provided to recognise that they would need to halve the number of moles they calculated for NaOH, so they divided their answer from (d) by 2. They then divided that answer by their average volume from (c) in dm^3 . The question stem also asked that candidates, 'Give your answer to three significant figures'. Some candidates did not give their answer to three significant figures, even though they had done the calculation correctly. Candidates should be reminded to follow the guidance of the question stem, as they will not achieve full credit if they do not give answers to the precision requested. The expected answer was 0.500 mol/dm^3 .
- (f) (i) Candidates were given the formula of ethanedioic acid and the mass of ethanedioic acid (6.3 g) in 100 cm^3 of the aqueous solution. They were asked to calculate the relative formula mass of ethanedioic acid using their answer from (e). The expected answer was 126. There were various acceptable methods to get this answer. One correct method, which several successful candidates used, was to multiply their answer of the concentration from (e) by 0.1, giving the number of moles in 100 cm^3 . They then divided the mass, 6.3 g, by this number of moles to give the relative molecular mass. Candidates who incorrectly calculated the number of moles in the first step were still able to receive an error carried forward mark, if they clearly indicated they were dividing 6.3 g by their number of moles. Candidates should be encouraged to lay out their answers to calculations clearly, indicating what the calculated values refer to e.g. number of moles, mass, concentration etc. so that error carried forward marks are accessible.

- (ii) Using their answer to **(f)(i)** candidates were asked to deduce the value of n (the number of moles of water in the formula of the hydrated compound). Successful candidates calculated the M_r of $C_2H_2O_4$ then subtracted this value from their answer to **(f)(i)**. This gave an intermediate value which was divided by 18 (the M_r of H_2O) to give the final answer. The expected answer was 2.
- (g) Candidates were asked why the conical flask in the titration is placed on a white tile. Many candidates correctly stated that it is to see the colour change more clearly. It should be noted that all three parts of this statement were needed. Some candidates just mentioned seeing the colour, but the important part of a titration is the endpoint, when the colour changes. Others omitted the colour and just said 'the change' but they needed to say what type of change they were looking for. Finally, some did mention the colour change, but did not say how the white tile would help. The colour change would be visible without the tile, the key point is that the colour change could be seen more easily, or more clearly.
- (h) Most candidates successfully stated that a measuring cylinder is not used in this experiment because it is not accurate, or precise enough.

Question 3

- (a) (i) The majority of candidates were able to describe how a gas is passed through limewater. This question could have been answered with a description, a diagram or both. When a diagram was drawn, some candidates did not draw the delivery tube going into the limewater. In successful diagrams it was clear that the delivery tube was entering the limewater.
- (ii) Candidates were required to give two observations from test 1. Test 1 involved the addition of a white powder, **Y**, into excess dilute acid. Candidates could see in Table 3.1 that a colourless solution forms and limewater becomes milky. They needed to give two observations in addition to those. Most candidates recognised that carbon dioxide was produced. However, just stating that a gas, or carbon dioxide, is produced is not an observation. The candidates needed to clearly state what they would see. Therefore, they could say they would see fizzing, effervescence, or bubbling, which were the most common correct statements. Candidates should also recognise that the solid would disappear, or dissolve.
- (iii) Most candidates correctly identified the gas as carbon dioxide.
- (iv) Most candidates successfully identified the anion as a carbonate. Candidates should recognise that the 'Notes for use in qualitative analysis' pages at the back of the question paper are there to be referred to.
- (v) Candidates were asked to use the results from test 2 to identify the acid used in test 1. Test 2 involved the addition of nitric acid and barium nitrate. A white precipitate was observed. Using the 'Notes for use in qualitative analysis', candidates should have identified that the test described in test 2 is a test for sulfate ions. In **(a)(iii)**, the only anion in solid **Y** was identified as a carbonate, so the sulfate ion must have come from the acid which was used in step 1, hence the correct answer is sulfuric acid. Most candidates successfully identified the acid.
- (vi) Several different ions were given by candidates as the answer for this question. Successful candidates used the 'Notes for use in qualitative analysis' and recognised that the cation in **Y** must be zinc, Zn^{2+} . Candidates should be reminded that for any of the 'identify' questions, any formulae that they give must be correct. If they are unsure, they can copy how it is written from the 'Notes for use in qualitative analysis'.
- (b) (i) This question asks candidates to state why it is not correct that **Z** contains Cu^{2+} ions. The start of **(b)** states that, 'Solution **Z** is colourless'. Better performing candidates recognised that Cu^{2+} ions are blue, and that solution **Z** is colourless. Other candidates got confused by talking about the colours of precipitates in the 'Tests for aqueous cations', which was irrelevant, they simply had to state that Cu^{2+} ions would not be colourless.

- (ii) Successful candidates clearly stated the procedure for completing a flame test. They stated that a wire or splint should be placed in solution **Z**, then held in a blue Bunsen burner flame and the colour of the flame (lilac) observed. Some candidates seemed not to have had experience of completing a flame test and, although they got the 'lilac flame colour' from the 'Notes for use in qualitative analysis', they were not able to describe the process.
- (iii) This question asked candidates to describe a test to identify which Group VII ion is present in **Z**. Successful candidates consulted the 'Notes for use in qualitative analysis' and clearly stated that nitric acid and silver nitrate should be added and the colours of the precipitates observed. The best responses linked the precipitate colours to the Group VII ions, white for chloride, cream for bromide and yellow for iodide. Other responses incorrectly referred to the gas test for chlorine. Candidates should ensure they carefully read both the question and the notes sheets in order to give the correct tests.

Question 4

In the question stem, candidates were told that argentan is an alloy containing zinc, nickel and copper. They were told that zinc and nickel react with dilute hydrochloric acid, but that copper does not. Using this information, they were asked to plan an investigation to find the percentage by mass of copper in a powdered sample of argentan.

Although most candidates answered this question to a high level, some candidates did not appreciate that the zinc, nickel and copper were in an alloy and described a method as if they were using three separate powders.

Candidates were asked to consider the apparatus needed, the methods and measurements, accuracy and the calculation.

Apparatus: Better performing candidates not only gave a suitable piece of apparatus to use for their reaction, e.g. beaker or conical flask but also clearly stated that they would carry out their reaction in it. If the apparatus was simply listed, but its use was not described, then the candidates did not get credit for the 'apparatus' section.

Method to use and measurements to take: The best responses described how to weigh the argentan sample, add hydrochloric acid to the sample, filter the unreacted copper and then re-weigh the copper. Some candidates missed out the initial weighing step, or when filtering they stated that they were removing the zinc and nickel.

Accuracy: Better performing candidates described that hydrochloric acid should be in excess, or that the reaction should continue until effervescence ends. They described washing and drying the copper after filtering it and recognised that they should repeat the investigation and calculate an average. Of the four bullet points in **Question 4**, the accuracy statement was the one that was most frequently missed out. Candidates should be advised to re-read their answer and consider carefully if they have met all of the bullet points. Successful candidates made rough notes next to the question stem, so they did not forget to cover any of the required areas.

Calculation: Most candidates successfully gave an acceptable calculation to obtain the percentage by mass of copper in argentan.

CHEMISTRY

Paper 5070/42 Alternative to Practical

Key messages

There continues to be evidence that candidates are answering questions based more on theoretical knowledge than from practical experience. It is important that candidates have as much opportunity as possible to do experiments, see equipment and make observations for themselves.

General comments

Overall, candidates showed a good understanding.

Comments on specific questions

Question 1

- (a) Most candidates realised that sulfuric acid is required to make copper sulfate. A few suggested other acids and some clearly did not understand the reaction and suggested other compounds.
- (b)(i) Many candidates did not know the name of an evaporating dish. Some simply called it a dish or a bowl and a few suggested completely inappropriate pieces of apparatus such as a conical flask or volumetric flask.
- (ii) Stating that the candidate stops heating when the solution becomes saturated was insufficient. A description of an observation was required. Better performing candidates described a way of testing for saturation and others wrote about crystals appearing or the volume of the solution decreasing. A few candidates misunderstood the experiment and wrote about heating to dryness.
- (iii) Very few candidates gained full credit. Many candidates incorrectly suggested that the evaporating dish will break or wrote about safety issues but did not specifically mention the issue of the solid spitting out of the dish. Some candidates thought that copper(II) sulfate was flammable. Some candidates stated that the water bath provides more gentle heat or words to that effect but very few wrote about the need to form hydrated crystals and to avoid the formation of the anhydrous product.
- (iv) Most candidates realised the last step was drying the crystals. A few candidates incorrectly dried the crystals and then washed them again.

Question 2

Candidates generally found (d)–(f) difficult. Some candidates omitted one or more of these parts.

- (a) Most candidates were able to read the diagrams of the burette correctly. A significant number of candidates did not show all figures to one decimal place, particularly when the value is 0.0. A few candidates read the scale incorrectly and some thought that the initial reading was 50.0 cm³.
- (b) There were a wide range of answers to this part with some ticks appearing in apparently random places. However, many candidates recognised they needed to select the two values that were closest together and within 0.2 cm³ of each other. Some candidates did not follow the instructions correctly and ticked either one value or more than two values.

- (c) Most candidates could calculate a correct average of their ticked values. Some candidates calculated an average of all four values.
- (d) A common error was to use the value of 24 or 24000 in the calculation, presumably because they were thinking of the volume of one mole of gas at room temperature and pressure. Another common error was to try to use an M_r or A_r value.
- (e) Very few candidates gained full credit. Some candidates multiplied their answer to (d) by two instead of dividing by two from the molar ratio in the equation. Candidates who obtained the answer of 0.200 often did not express it to three significant figures as was specifically required in the question. Candidates were awarded partial credit if they did an incorrect calculation but expressed their answer correctly to three significant figures.
- (f) This question was more difficult because less structure was given to the calculation and candidates needed to do a three-step calculation to gain full credit. Many candidates correctly determined the molar mass but then did not know how to use it in the rest of the calculation. The mark scheme shows one method for the calculation, but credit was given for any correct method.
- (g) Many candidates correctly described the idea of needing to mix the contents.
- (h) Many candidates realised that adding dropwise increased the accuracy of the titration by avoiding overshooting the end-point. The most common error was to write about the ease of seeing the colour change.

Question 3

- (a) (i) There was a fairly even spread of marks from 0–3 for this question. Most candidates knew the flame turned yellow or that they needed to observe the colour of the flame. Some candidates realised they needed to dip a suitable piece of apparatus into the solution or use a spray to introduce the solution into the flame. Some candidates thought that the flame would change colour if they heated the solution in a test tube. Few candidates stated that a blue Bunsen flame was needed or that the air-hole should be open.
- (ii) Most candidates performed well on this question as is expected, as they are given the quantitative analysis notes. A few candidates incorrectly thought that the question required them to test for oxygen gas. Most candidates who did not gain full credit omitted some of the detail from the test.
- (b) (i) Most candidates identified the cation. A few candidates wrote chromium without the oxidation state. The oxidation state is given on the quantitative analysis notes and should be used even though candidates are not expected to be aware of other oxidation states for chromium.
- (ii) Many candidates were aware of the need to add dilute nitric acid. Some suggested adding acid but without saying that it need to be nitric acid. Common errors were to name a wrong acid or suggest adding excess silver nitrate.
- (iii) Most candidates correctly stated chloride or gave a correct formula for a chloride ion. Some candidates said it was chlorine or a chlorine ion, which was unacceptable. A few candidates suggested sulfate.
- (iv) Many candidates got this correct but a significant number automatically wrote that a white precipitate was formed based on the test that was used. They had not taken note of the fact that their answer to (iii) was the only anion present. A few candidates said that a colourless solution was formed. Although this is often the case in negative sulfate tests, here the solution is green.
- (v) Many candidates correctly described effervescence but some simply stated that carbon dioxide is formed. This is a conclusion and not an observation.

Question 4

Candidates continue to find the planning question quite difficult. The quality of the answers was very variable. Most candidates made an attempt at an answer, but many did not address all of the bullet points in the question. Candidates cannot gain full credit unless they write about all of these points.

Some candidates misunderstood the question and thought they had been provided with separate samples of zinc and copper.

Some candidates did not gain credit because they described a completely inappropriate method such as distillation or using a magnet. Some candidates suggested electrolysis as a method and gained some credit. Using a method which involved collecting and measuring the volume of hydrogen gas was completely acceptable but few of the candidates who chose this method were able to describe it appropriately or knew how to use the data to obtain the percentage of zinc.

Those candidates who described an appropriate method often did not write about techniques that ensured accuracy and/or did not show how to use the data they collected to calculate the percentage of zinc. Calculation of the percentage of copper instead of zinc was quite common.

A very common mistake was for candidates to add the acid to the Muntz, filter the mixture but then go on to suggest that if they evaporated the filtrate they would then obtain zinc crystals.

Some answers were excellent with candidates addressing seven or eight of the marking points to gain the maximum six marks.