CHEMISTRY

Paper 5070/11
Multiple Choice

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

General comments

Question 3 and **Question 26** were found to be easy.

Candidates found **Questions 12** and **39** particularly challenging. There was evidence of candidates guessing the answer to **Question 15**.

Comments on specific questions

The choice of option in the following items shows where candidates may have gaps in their knowledge, skills and/or understanding.

Question 5

Just over half the candidates chose the key, option **B**, with many candidates selecting either options **A** or **C** instead. This suggests that candidates were unfamiliar with this type of calculation where the relative mass of the missing isotope is calculated rather than the relative atomic mass of the element.

Question 12

Some candidates found this a challenging question. It is slightly unusual in that it requires candidates to work out the volume of gas that would be left at the end and add it to the volume of the product.

Question 15

A minority of candidates selected the key and there is evidence of guessing with significant numbers of candidates choosing one of the incorrect options. This suggests that changes in the concentration of the electrolyte during electrolysis is not well understood by candidates.

Question 17

Option **D** was an incorrect choice by some candidates. The data suggests that other candidates were able to narrow down the choice to either options **C** or **D** but then did not understand the link between the gas released and the mass lost.

Question 18

Some candidates chose option **B**. Candidates often make mistakes with the logic required to work out the effect of temperature on the position of an equilibrium.

Question 22

Option **A** was a common incorrect choice. When working out which period an element is in, candidates frequently overlook Period 1 that contains just hydrogen and helium.

Question 24

Some candidates chose option **A**. It is a common misunderstanding that all the noble gases have eight electrons in their outer shell; helium does not.

Question 27

Some candidates chose option **D**. This suggests that candidates did not understand that galvanising provides protection through both a barrier method and through sacrificial protection.

Question 36

Option **C** was a common incorrect choice. The data suggests that many candidates understood that the first process is cracking but were then unsure of the correct catalyst for the addition of hydrogen to an alkene.

Question 39

Options **B** and **D** were both selected by more candidates than the key, option **A**. This suggests that candidates did not understand that the sample would be a solid and so purification by distillation is not appropriate. It also suggests that candidates did not understand that impurities in a sample typically lower its melting point.

Question 40

Nearly half of the candidates chose option **B**. Choosing the correct answer depends on candidates knowing the slight differences in the results of the tests for iron(II) ions and chromium(III) ions. The data suggests that many candidates were guessing between these two options.

CHEMISTRY

Paper 5070/12
Multiple Choice

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

General comments

Question 2 was found to be easy.

Candidates found **Questions 10** and **32** particularly challenging. There was evidence of candidates guessing the answer to **Question 39**.

Comments on specific questions

The choice of options in the following items shows where candidates may have gaps in their knowledge, skills and/or understanding.

Question 1

Option **D** was a popular choice. These candidates may have focused on the idea that the pentane molecules are free to move whilst ignoring the information given earlier in the question.

Question 4

Many candidates chose option **A**. It is likely that they overlooked the fact that the numbers of particles given in the question refer to an ion of the element rather than to an atom of the element.

Question 10

Candidates found this a challenging question and many chose option **A**. This is a challenging question that requires writing a correct equation for the reaction. The data suggests that some candidates overlooked the fact that some of the oxygen would still be present at the end of the reaction.

Question 13

Option **C** was a common incorrect answer. These candidates were confused between the electrolysis with copper electrodes and the electrolysis with inert electrodes.

Question 15

Option **A** was a more popular choice overall than the key, option **B**. Option **A** is the only option that looks like a 'reaction' in that it has multiple reactants forming a product. It seems likely that many candidates did not appreciate that this is a question about bond breaking and bond making.

Question 21

Option **C** was chosen by roughly the same number of candidates as the key, option **D**. The data suggests that some candidates did not understand the significance of the reversible reaction symbol in the context of weak and strong acids.

Question 32

There was little discrimination between candidates on this question. Options **A** and **B** were common choices, with a minority choosing the key, option **C**. It seems likely that many candidates overlooked the fact that the carbon chain may be branched to give different structural isomers.

Question 34

Option **A** was commonly chosen. This data suggests that some candidates did not understand that when an organic molecule contains two instances of a particular functional group, both instances of the functional group usually undergo the same reaction.

Question 37

The majority of candidates chose option **C**. The data suggests that many candidates were unable to interpret the chromatogram correctly.

Question 39

There was some evidence of guessing here. The question hinges on recognising that the two solids are both insoluble in water and then selecting the appropriate separation technique. It seems likely that many candidates did not know the solubility in water of the two compounds.

CHEMISTRY

Paper 5070/21
Theory

Key messages

- Candidates need to read questions carefully so they answer what is being asked e.g. **Question 4(c)(i)** where the question stipulated two significant figures and **Question 6(d)(i)** which asked for the effect on acidity not just on the position of equilibrium.
- More candidates showed their working in calculation questions. This is good examination practice as it allows error carried forward marks to be awarded where appropriate.
- Where an equation is required, candidates need to make sure that the individual formulae are correct before they balance the equation.
- In redox reactions, candidates need to appreciate it is the species within the compound which is either oxidised or reduced not the compound.
- Candidates need to give the name of a substance if a name is required and the formula of a substance where a formula is required. Where a question asks for an identity, candidates are advised to give the name rather than the formula.

General comments

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

Candidates found organic chemistry and writing equations particularly challenging.

Comments on specific questions

Question 1

(a) Insoluble salt was quite well known. Common incorrect responses included calcium chloride, aluminium chloride and potassium bromide, with silver nitrate being the most common.

(b) The test for copper(II) ions was well known. All of the other salts were seen.

(c) The test for nitrate ions was quite well known. Sodium bromide, sodium sulfite, potassium manganate(VII) and potassium iodide were seen often.

(d) Potassium iodide as a test for a reducing agent was not well known. Potassium manganate(VII) was the most popular incorrect response.

(e) The choice of a solution of a metal with lower reactivity than copper proved a little challenging. Copper sulfate, barium sulfate and calcium chloride were popular responses.

Question 2

(a) (i) Candidates found this very challenging. Bonding was frequently named as giant covalent without describing the use of only three electrons in covalent bonding thus leading to delocalised electrons in the structure. Of those who cited delocalised electrons, few described them as mobile. Many thought the bonding was ionic leading to mobile ions conducting the electricity.

(ii) The inertness of graphite was well known. High boiling point, light and cheap were common incorrect responses.

(b) The products were quite well deduced. Many thought oxygen was produced at the anode and hydrogen at the cathode. Bromide was also seen at the anode and bromine at the cathode.

(c) The cathode equation was better known than the anode. Many gave oxide forming oxygen, usually unbalanced at the anode, and unbalanced hydrogen equations forming $2H_2$ from $2H^+$ or H from H^+.

(d) (i) This was generally well answered. Common incorrect responses included H_2O_2, CO and CO_2.

(ii) Candidates found this very challenging. Non-creditworthy responses included rusts easily, explosive, flammable, expensive, water evaporates and polluting.

Question 3

(a) Generally well known. The most common non-creditworthy responses were high temperature and heat.

(b) Whilst the basic premise of substitution seemed to be understood, many described substitution as 'substitute' rather than explaining the term.

(c) Most candidates calculated the bond breaking and bond forming energies correctly. A small number reversed the subtraction.

(d) The diagram was generally well understood and it was often careless drawing which resulted in partial credit. The ΔH arrow needs to begin from the products and end at the reactants. Common errors included upwards arrows, lines with either no arrowhead or two arrow heads or lines that were too short or too long. The E_a arrow needs to begin at the reactants and end at the top of the hump. Common errors included arrows starting from the products, arrows which were too short or did not go to the top of the hump. A significant number drew endothermic diagrams or reversed the reactants and products on an exothermic diagram.

(e) The electronic configuration of methane was very well known. Incorrect responses included one electron in the single bonds and non –bonding electrons on either carbon or hydrogen.

Question 4

(a) The majority of candidates gave the correct general formula. Common errors included $C_nH_{2n+2}OH$ or just –OH.

(b) Most candidates gave at least one general characteristic. Incorrect responses included same physical properties or repeating the properties given in the question stem.

(c) (i) Most of the better performing candidates calculated the volume correctly. Many did the correct operations but often rounded the intermediate answers so that the final answer was incorrect, incorrectly rounded or did not give the answer to the required two significant figures. Some used the M_r of ethanol instead of sodium or used the incorrect stoichiometry from the equation.

(ii) Better performing candidates cited the correct ion. Incorrect responses included hydrogen, sulfate, sulfuric acid and copper.

(d) Many candidates gave one correct use, usually as a fuel. Non-creditworthy responses included perfume, drinks and detergents.

(e) The reagent was well known but the conditions proved more challenging. The temperature was frequently too high, the pressure too low and the catalyst nickel. Hydrogen was sometimes given as the reagent.

Question 5

(a) The term hydrocarbon was well known. The most common error was to omit the exclusivity to carbon and hydrogen.

(b) (i) This proved extremely challenging for most candidates. Many did not consider that octane was combusting incompletely and so gave $CO_2 + C \rightarrow 2CO$ or gave the complete combustion of carbon, $C + O_2 \rightarrow CO_2$.

(ii) Better performing candidates gained partial credit usually for the equation. Many discussed the incomplete combustion of nitrogen $N_2 + 2O_2 \rightarrow 2NO_2$ or the combustion of nitrogen monoxide, $2NO + O_2 \rightarrow 2NO_2$. Some thought the nitrogen was in the petrol rather than from the air. Those that gave nitrogen reacting with oxygen usually omitted the high temperature of the engine being required for the reaction. A significant number omitted the question.

(c) (i) Candidates found this very challenging with most discussing the oxidation and reduction of the compounds rather than the species within the compound. Some reversed the processes.

(ii) Lowering of activation energy was well known. Some discussed only the alternative pathway or repeated the stem of the question.

(iii) Almost all candidates appreciated that the rate would increase. Many discussed an increase in kinetic energy without relating it to the particles or described the frequency of the collisions increasing rather than the success of the collisions. A small number of candidates considered activation energy.

(iv) Candidates found this quite challenging with many discussing the particles having decreased kinetic energy and moving more slowly as the pressure decreased. Few appreciated that there would be fewer particles per unit volume. Many discussed the decreased success of the collisions rather than their decreased frequency.

Question 6

(a) (i) Around half of the candidates gained credit. Many repeated the data in the question stem rather than interpreting it. Incorrect responses included higher than the melting point, lower than the boiling point and between the melting point and boiling point.

(ii) Most gained at least partial credit often for vibration. Many gave the particles as regular or in a pattern but far fewer considered the closeness or tight packing of the molecules. In a fixed position was frequently cited but this does not describe either the closeness or the regularity of the molecules.

(b) Candidates who performed well overall gained credit. Many inverted the fraction, multiplied the numbers of molecules or gave the power as 10^{43}. A significant number multiplied by the A_r rather than the M_r of chlorine.

(c) (i) Oxidation numbers were quite well known. Common errors for Cl_2 included +2, +1 and –1. The chloride ion was more well known. Common errors included 0 and 1.

(ii) Almost all candidates gained credit. Errors included losing electrons and chloride gaining electrons.

(d) (i) Whilst many candidates appreciated the shift of the equilibrium to the left, far fewer discussed the decrease in acidity. Many shifted the equilibrium to the right because the reaction is exothermic.

(ii) The difference between strong and weak was well known but few candidates defined the acid as donating hydrogen ions.

(e) Empirical formula was well known. Incorrect responses included using 34.5 as the percentage for iron and chlorine, only using the chlorine percentage and so giving the answer only in terms of chlorine, inverting the mole calculation and dividing chlorine by 71.

Question 7

(a) The whole variety of metal properties were seen and the most popular responses were light or lightweight rather than low density.

(b) Many appreciated the oxide layer formed on the surface of the aluminium but few explained the resistance to corrosion caused by the layer. Many thought aluminium was too unreactive to corrode.

(c) The formula of aluminium sulfate proved to be very challenging with many incorrect responses including $AlSO_4$, $AlSO_3$ and Al_2SO_4.

(d) Amphoteric was well known. Common incorrect responses named elements such as aluminium, zinc and iron.

Question 8

(a) (i) The term was well known. Non-creditworthy responses did not specify that the double bond was between carbon atoms.

(ii) Better performing candidates remembered the test for unsaturation. Incorrect responses included bromide, copper sulfate and hydrogen chloride. Some reversed the colour change or gave bromine as red or red-brown. A significant number omitted the question.

(b) (i) The type of catalyst was not well known and all of the catalysts mentioned in the syllabus were seen with nickel and aluminium oxide being the most common. H_2SO_4 was also a common non-creditworthy response since acid was not included with the formula. A significant number omitted the question.

(ii) The alcohol was well deduced. Ethanol and butanol were also common responses.

(iii) This displayed formula proved challenging with only the better performing candidates gaining credit. Some gave displayed C_3H_7 or C_3H_5 with no double bond and many omitted the bond between the O and the H.

(c) (i) Candidates found this challenging. Many candidates put the side chains into the carbon backbone, drew one repeat unit or poly(ethene) or omitted the continuation bonds. A significant number omitted the question.

(ii) Many candidates gave the correct mass. The most common incorrect response was 20 g. Those that gave 80 g often had the explanation of the yield being 100%. Those that gave 20% usually discussed by-products being formed, often water, or calculated 100 – 80 to give 20 g. A significant number omitted the question.

(d) Many candidates knew the definition. Common errors included same compound, same atoms, same chemical properties, same molecular structure and same general formula.

CHEMISTRY

Paper 5070/22
Theory

Key messages

- Candidates must distinguish between the factors that affect rate of a reaction with those that affect the position of equilibrium.
- Candidates must be able to distinguish between molecular formulae and structural formulae.
- Candidates need to be able to describe the manufacture of organic products such as vinegar and include the relevant reactants and conditions.

General comments

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

In some quantitative questions, candidates did not show sufficient working out and as a result error carried forward marks could not be awarded.

Candidates must appreciate that reactions at the anode will lose electrons and reactions at the cathode will gain electrons.

Comments on specific questions

Question 1

Almost all the candidates followed the rubric and gave the name of the salt rather than the formula. Candidates very rarely gave more than one answer.

(a) Silver chloride was often given by candidates as a salt that is prepared using a precipitation reaction. Barium chloride was a common incorrect answer.

(b) Sodium bromide was often given by candidates as having a yellow flame in the flame test. Potassium iodide was a common incorrect answer.

(c) Many candidates recognised anhydrous potassium manganate(VII) as a salt that dissolves to form a dark purple solution. The most common incorrect answer was potassium iodide.

(d) Candidates found this question quite challenging. The most common incorrect answer was aluminium sulfate.

(e) Candidates often recognised that aqueous bromine reacts with aqueous potassium iodide. The most common incorrect answers were sodium bromide and potassium manganate(VII).

Question 2

This question was about electrolysis.

(a) (i) Many candidates referred to graphite having a giant covalent structure, but a significant proportion of the candidates then described intermolecular forces, which contradicted their answers. The best answers appreciated that graphite had a giant structure with many strong covalent bonds. Candidates who performed less well referred to unspecified strong bonds. A common misconception was to refer to strong intermolecular bonds. Another misconception was to refer to graphite being a giant covalent bond.

(ii) Some candidates referred to graphite being inert or unreactive, but this property was given in the stem so was not given credit. The most common correct answer appreciated that graphite had good electrical conductivity.

(b) Some candidates appreciated that oxygen was formed at the anode and hydrogen at the cathode. Both chlorine and magnesium were common incorrect answers. A significant proportion of the candidates gave the ionic half-equations rather than the name of the product.

(c) Candidates were much more likely to give the correct ionic half-equation for the cathode than for the anode. Some candidates gave the reaction of hydroxide ions rather than oxide ions to form oxygen. Candidates struggled to balance the anode half-equation and often had the electrons on the incorrect side of the equation. Although the addition of electrons to an aluminium ion was more likely to be correct a significant proportion of the candidates gave either Al_3 or Al_2 as the product.

(d) Candidates often gave one or both correct answers. Copper was well known as the anode, although some candidates referred to impure copper. Copper(II) sulfate was the most common electrolyte given but any soluble copper(II) compound was allowed. Candidates rarely referred to the state of the copper(II) sulfate for example aqueous copper(II) sulfate.

Question 3

This question focused on the reaction between ethene and bromine.

(a) Many candidates appreciated that the final observation would be colourless or that the bromine was decolorised. A common misconception was that the initial colour of bromine was red or a shade of red. The accepted colours for bromine were yellow, orange or brown.

(b) Many candidates were able to use the bond energies to show that the enthalpy change of reaction was –107 kJ / mol. The most common approach was to add up all the bond energies in the reactants and take away all the bond energies in the products.

(c) Most candidates attempted to draw the reaction pathway diagram for an exothermic process. Some candidates gave incorrect formulae for the reactants and products rather than just giving the names reactant and product. A common misconception was to draw the enthalpy change with no indication of the direction for example an arrow in the correct direction or a label with ΔH –. Some candidates drew arrows where it was difficult to decide where the arrows started or where they finished. Candidates should be advised to use construction lines to indicate the energy level of the reactant and of the product to aid their answers.

(d) Most candidates drew a covalent dot-and-cross diagram, although the diagram was often incorrect. Some candidates did not draw a double bond between thew carbon atoms and/or included lone pairs on the carbon atoms. Some candidates did not draw ethene but drew methane or ethane instead.

Question 4

This question was about the homologous series of carboxylic acids.

(a) The general formula was written in a variety of ways for example $C_nH_{2n}O_2$ or $C_nH_{2n+1}COOH$. Candidates should be advised to make certain to show subscripts carefully for example $C_nH_{2n+1}COOH$ rather than $C_nH_{2n}+1COOH$. A common misconception was that some candidates put a plus symbol between the carbon chain and the carboxyl group.

(b) Many candidates recognised the importance of having the same functional group, although some candidates just referred to the same general formula.

(c) (i) Most candidates gave the correct name of calcium ethanoate.

(ii) A significant proportion of the candidates did not show all the necessary working. In particular the relationship between the moles of calcium atoms and the moles of hydrogen molecules was often missing. Some candidates gave answers that had two significant figures; some gave one or three significant figures.

(d) Candidates found this recall question very challenging and rarely appreciated that ethanoic acid is manufactured by the bacterial oxidation of ethanol. A significant proportion of the candidates did not answer this question. Some candidates used potassium manganate(VII) as the oxidising agent, but this reagent is not used to make vinegar. Typically, candidates focused on the manufacture of ethanol rather than the subsequent oxidation of ethanol.

(e) (i) Candidates often gave a structural formula rather than the molecular formula of $C_4H_8O_2$.

(ii) Some candidates drew the displayed formula of propanoic acid, but other candidates did not show the carboxyl group with all the bonds shown. A small proportion of candidates gave butanoic acid or pentanoic acid instead.

(iii) Candidates often described the reaction between propanoic acid and sodium carbonate without giving an observation. Candidates often appreciated that carbon dioxide was made and even gave the test for carbon dioxide with limewater but did not describe that the mixture would bubble.

(iv) Candidates often named sodium butanoate as a product but were less certain about the formation of water and either gave only sodium butanoate or sodium butanoate and hydrogen.

Question 5

This question was about the combustion of fossil fuels.

(a) (i) Candidates often appreciated that carbon dioxide and water were the two products and then attempted to balance the equation. Many candidates balanced the equation and often they used fractions rather than integers to balance the equation.

(ii) Candidates did not have to identify the air pollutant made during the combustion and only had to state an adverse effect. The most common answers were global warming, climate change or an increased greenhouse effect, with only a small proportion of candidates giving a consequence of global warming. Some candidates referred to a toxic gas which was not credited.

(iii) The use of fractional distillation or a fractionating column was mentioned in many answers although a small proportion of the candidates referred to cracking instead. Many candidates then stated that the petroleum was heated and separated due to differences in boiling point. A common misconception was that diesel was heated rather than the petroleum and that differences in melting point or density allowed fractional distillation to work. Some candidates thought that petroleum was petrol as opposed to crude oil.

(b) (i) Most candidates referred to acid rain. Only a very small proportion of the candidates referred to ozone depletion.

(ii) The best answers showed how they deduced the formula as $CaSO_3$ normally by use of a symbol equation. Some candidates seemed to make a guess giving answers such as $CaSO_4$, $Ca(SO_3)_2$ or $CaSiO_3$.

(iii) Most candidates appreciated that the rate of reaction increases but they were not always able to give a detailed answer that referred to an increase in the number of successful collisions or an increase in the number of molecules with energy above that of the activation energy. Often candidates just referred to more collisions or a greater collision frequency, which was not sufficient. Candidates also mentioned an increase in kinetic energy but did not always link this to particles and merely made a statement that the kinetic energy increases.

(iv) Many candidates appreciated that the rate of reaction decreases but were not always able to explain their answer with sufficient clarity. The decrease in surface area was sometimes mentioned and answers often mentioned a decrease in the collision frequency.

Question 6

This question focused on the chemistry of bromine.

(a) (i) Some candidates appreciated that –50 °C was lower than the meting point of bromine. Candidates often referred to the boiling point of bromine being higher than –50 °C even though this was irrelevant.

(ii) Candidates were often able to describe the arrangement and motion of bromine molecules in a solid. Candidates often referred to the particles vibrating about a fixed point. Some candidates thought that the particles being in a fixed position meant the arrangement of molecules was regular, but this reference was not given credit. Answers had to specifically mention that the molecules were in an ordered pattern or that they were in a lattice. The idea that the molecules were close together and touching each other was often expressed by referring to molecules being tightly or closely packed.

(b) Candidates found this question challenging and were only rarely awarded full credit. Candidates often gave 3200, an answer that used the molar mass as 80 rather than 160. Others calculated the amount in moles but did not go any further.

(c) (i) Candidates were more likely to state that the oxidation number of bromine in Br^- was –1 than O in Br_2.

(ii) Most candidates appreciated that bromine gained electrons and so was reduced.

(d) (i) Candidates had to refer to the position of equilibrium moving or shifting to the left rather than the reaction favouring the left. Good answers explained the shift in terms of the forward reaction being exothermic or the backward reaction being endothermic. Alternatively, the candidates could refer to energy being absorbed in the backward reaction or released in the forward direction.

(ii) Candidates had to refer to no shift or movement in the position of equilibrium. A common misconception was that there was no reaction. In terms of the explanation a significant proportion of the candidates referred to the number of moles of gas in the reactants and products but did not mention the significance of these moles being gases.

(e) Some candidates did not appreciate they had to calculate the percentage by mass of bromine before starting the empirical formula calculation. The most common misconception was to use the molar mass of a bromine molecule to calculate the amount in moles of bromine. Many candidates supported their empirical formula with the appropriate working out.

Question 7

This question was about iron and steel.

(a) Many candidates referred to the hardness of steel. Common answers that were not given credit were having a low density, good thermal conductivity or it is durable.

(b) Candidates often appreciated that alloys contained metals or metals and non-metals but often neglected to include that an alloy is a mixture. Candidates sometimes referred to metals combined together but this was not given credit since it implies a compound rather than a mixture.

(c) Candidates were more likely to explain sacrificial protection than galvanisation as a barrier protection. A common misconception was to refer to zinc rusting instead of the iron, however zinc corroding rather than iron was given credit. When describing barrier protection candidates often referred to the layer stopping the reaction between oxygen or water with iron rather than the barrier preventing the oxygen and water reaching the iron. Some answers were quite confused describing sacrificial protection and barrier protection together as though they were the same.

(d) Many candidates found this question challenging because they could not write the formula for iron(III) sulfate. Some candidates gave the formula for iron(II) sulfate instead and others gave formulae such as Fe_3SO_4 or Fe(III)SO_4. If the correct symbol equation was written, many candidates were then able to include the correct state symbols.

Question 8

This question was about esters.

(a) (i) Candidates who referred to the lack of carbon-carbon double bonds found this question easier to answer than those that referred to carbon-carbon single bonds. Answers that stated the molecule had carbon-carbon single bonds were not sufficient unless it was clear that all the carbon-carbon bonds present were single bonds. References to double carbon bonds or single carbon bonds were not sufficient.

(ii) The best answers referred to the presence of the hydroxyl functional group. Answers that gave the formula of the hydroxyl group –OH were also given full credit. A common misconception was to refer to hydroxide or to put the formula as OH^-.

(iii) The functional group present in esters was less well known than the functional group of an alcohol and sometimes candidates just referred to the presence of an ester linkage without trying to identify the atoms present. A common misconception was to state that there was an acid and an alcohol in the structure.

(b) Candidates often appreciated that **A** and **B** had the same molecular formula but only the best answers actually gave the molecular formula.

(c) (i) Candidates often gave the name of a catalyst rather the type of catalyst used in esterification. Correctly named catalysts such as sulfuric acid or phosphoric acid were allowed.

(ii) More candidates could draw the formula of the alcohol used than name the alcohol. Some candidates did not include the bond between the oxygen atom and the hydrogen atom in the hydroxyl group. In terms of the name, propanol was not sufficient candidates had to appreciate it was propan-1-ol.

(d) (i) Some candidates were able to draw the repeat unit for the polyester. The most common misconceptions were to draw the carbon chains between the carboxylic acid hydroxyl groups in the monomers as boxes without showing the structure. Some candidates forgot the continuation bonds and others included either too many or too few oxygen atoms.

(ii) Many candidates appreciated that during condensation polymerisation a small molecule, often identified as water, was also made.

CHEMISTRY

Paper 5070/31
Practical Test

There were too few candidates for a meaningful report to be produced.

CHEMISTRY

Paper 5070/32
Practical Test

Key messages

- The notes for quantitative analysis at the end of the paper are provided to help candidates do their experiments and to interpret their observation. It is important that candidates are aware of these and use them effectively to help them in their answers.

Comments on specific questions

Question 1

(a) (i) Most candidates recognised that tap water contains a variety of different dissolved substances. Candidates could suggest any reasonable type of substance that would be dissolved in tap water. Alternatively, some candidates referred to the purity of distilled water.

(ii) Candidates need to be aware that the word 'clear' means transparent and is not the same as 'colourless'. Copper(II) sulfate for example is a clear, blue solution. Candidates needed to describe **X** as a colourless solution or liquid. Answers such as 'it looks like water' were too vague.

(b) (i) Candidates had to make a solution using a sample of **W** provided. A small variation in the mass of this sample would cause a significant effect on the titration results. For this reason, no credit was awarded for a comparison of the candidates' results to the supervisor result.

A significant number of candidates did not write all of their results to one decimal place. Writing 0 instead of 0.0 is the most common error in this regard.

Some candidates found it difficult to identify the best titration results. At this level, candidates are expected to know that results may be considered accurate if they are within 0.2 cm^3 of each other. They could also identify the best results by selecting the ones which are identical or closest to each other. Some candidates chose to tick just one result when there is no way to identify a single best result and candidates who did this usually chose the smallest value.

(ii) This mark was dependent on the candidate ticking results in **(i)**. Credit was only awarded when the average given was correct for the ticked values. Candidates who ticked just one value obtained credit by giving this value as the average. Candidates who averaged all of the titration results without reference to the ticks did not gain credit.

(c) This calculation was dependent on the candidate selecting correct values from the method rather than from their own results. Many candidates were able to do this calculation.

(d) Candidates needed to use the correct answer or by obtaining a different answer using their result for **(c)**. Many candidates recognised from the equation that they simply needed to divide their answer from **(c)** by 3.

(e) Very few candidates recognised the need to use their experimental result in this calculation. A common error was to suggest that the answer to **(e)** was the same as **(d)**.

(f) This calculation was straightforward and many candidates showed that they knew how to do the calculation. Some candidates recognised that they needed the number of moles of H_3A to do this calculation and if they could not do **(e)** they chose any number, e.g. 1, as their answer to **(e)** so that they could then multiply this by 210 to obtain an answer in **(f)**.

(g) Candidates generally repeated the question by saying that measuring cylinders were not accurate. Few candidates were able to give a reason for this lower accuracy by referring to the precision of the scale on the measuring cylinder. Some candidates thought that a 100 cm^3 measuring cylinder was able to measure to the nearest 0.1 cm^3. Far more candidates were aware that a burette, volumetric pipette or volumetric flask was more accurate.

(h) (i) Although many candidates referred to impurities in the burette, they did not always explain that the purpose of the distilled water is to remove these impurities.

(ii) Candidates' answers were often vague. The question specifically asks for the effect on the titration results so it was necessary for the candidate to state that the titration result would be greater than it should be. More candidates were able to explain that the effect was a result of the distilled water diluting **X**.

Question 2

(a) Many candidates were unable to explain how to do a flame test, even though they had apparently done the test and obtained a correct result.

Although there are a variety of techniques that can be used, using a spatula, test-tube, beaker or copper wire to introduce the solid into the flame is not acceptable. The best technique is to use a nichrome or platinum wire but, at this level, using a dampened splint is a suitable alternative.

Very few candidates referred to the essential requirement of using a Bunsen burner with the air hole open. A yellow flame from a Bunsen burner or the use of a spirit burner is not suitable for a flame test as the yellow colour masks the colour caused by the metal ion.

The copper ion colour is one of the easier colours to recognise in a flame test and most candidates were able to do this. Some confused the colour with the barium ion. Some candidates stated as their conclusion that copper was present. This was insufficient and they need to appreciate that the flame test is a test for cations.

(b) (i) Candidates should use the number of marks allocated to the question to help them appreciate how much detail is required in the answer. Some descriptions were quite vague.

Candidates need to read the whole question carefully before starting their practical and recording their results. In the stem of the question, it tells them to test and name any gases evolved. Many candidates overlooked this.

Although many candidates recorded that they saw effervescence/fizzing, few of them went on to say that the solid dissolved to form a blue/blue-green solution.

Many candidates did not go beyond identifying carbon dioxide to make the conclusion that a carbonate ion is present.

(ii) Most candidates recognised that effervescence would stop when the reaction was finished, even those candidates who did not give effervescence/fizzing as an observation in **(i)**.

(c) (i) This was generally answered well, although some candidates did not describe the initial pale blue precipitate before describing the dark blue solution.

(ii) This was generally answered well.

(d) Some candidates misunderstood this question and only named the cation present. This part tested the candidates' ability to put together a number of results. The identification of **A** had to match the experimental results the candidate had obtained. Candidates who obtained positive results for copper ions in **(c)** but had stated that barium or other ions were present from **(a)** needed to refer to this in their answer.

(e) Candidates should have been familiar with the silver nitrate test and therefore known what to expect for sodium chloride, potassium bromide and potassium iodide. The conclusion was based on the candidate's ability to match their answer from the test using **B** with results from the known substances. Candidates who obtained different results for **B** and for potassium bromide could not have done the tests correctly. Simply stating that **B** contained bromide ions without any experimental evidence to support this, would not have obtained credit for the conclusion.

Question 3

Many candidates followed the structure of the question and attempted to address each bullet point in turn, which often means that they do not miss out key information.

A significant number of candidates did not understand the question. The opening statement tells them that **Q** is a mixture. They should not, therefore, be doing experiments with separate samples of copper(II) carbonate and lead sulfate. Candidates who did this could not obtain full credit.

Some candidates did not name key pieces of apparatus needed in their method. This is specifically asked for.

Only the better performing candidates were aware of the need to use excess sulfuric acid to ensure that all of the copper(II) carbonate had reacted before they filtered the mixture.

Only these candidates knew that a melting point test is used to show the purity of a solid. Most candidates either thought that washing the sample proved it was pure or that doing some form of anion or cation test proved it was pure.

Weaker responses often muddled up the names of chemicals in their description, particularly misusing the names of copper(II) carbonate and copper(II) sulfate.

The addition of sulfuric acid had to be described in the correct context of adding it to **Q**. Adding acid to separate solids did not gain credit.

Filtration also had to be described in the correct context. Credit was only awarded for filtering the mixture of **Q** and acid and not for filtering the copper(II) sulfate crystals from any remaining filtrate after crystallisation. Filtering after adding acid to just copper(II) carbonate did not gain credit as there would be no residue to separate.

Heating the filtrate to dryness and hence obtaining anhydrous copper(II) sulfate was not acceptable.

Marks were credited from diagrams where this was appropriate.

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Paper 5070/41
Alternative to Practical

Key messages

- Candidates should be encouraged to read the question stem carefully and to regularly refer to it when answering questions. The question stem to **Question 1** held information relevant to all of the answers to **(a)**.
- Most candidates were very well practiced in titration calculations and correctly answered **Question 2(a)** to **(c)**. Other candidates need to carefully read the questions to determine how to answer them. They also needed to refer to previous parts of **Questions 2(c)** to **(f)**.

  Candidates should be reminded that the 'Notes for use in qualitative analysis' pages are there to be referred to, however, not all questions will relate to these pages. Their knowledge of other Chemistry reactions and techniques may also be tested as in **Question 3(a)(i)**.
- Candidates should take careful note of what is required by a question. In **Question 4**, they had to fulfil all five bullet points to gain full credit.

General comments

Candidates were very successful in a number of parts of this exam. Most candidates knew how to complete straight forward titration calculations in **Questions 2(a)** to **(c)** and how to correctly use the 'Notes for use in qualitative analysis in **Questions 3(a)(ii)** and **(f)**. They were also successful in their descriptions of filtration and crystallisation techniques in **Question 4**.

The times when candidates were not as successful could be greatly improved by careful reading of the question stem, identifying when their own knowledge is required (rather than that given in the 'Notes for use in qualitative analysis) and by ensuring that answers are specific to the context of the question.

Comments on specific questions

Question 1

(a) In the question stem for **(a)** an investigation was described to determine the solubility of ammonium chloride in water at 60 °C. When answering the following questions, candidates should be encouraged to refer back to this stem to assist them.

(i) Some candidates correctly recognised that, although the aim of the investigation was to determine solubility at 60 °C, taking the temperature was not referred to in any of the steps given. Therefore, 'measure the temperature' is the correct response. A common misconception here was that the mass of the bottle needs to be measured. Looking at the question stem, steps 3 and 7 take account of the mass of the bottle, so it is not necessary to weigh it.

(ii) The majority of candidates were successful in calculating the solubility of ammonium chloride. The first step involved calculating the difference between the two masses, giving 58.2 g. A number of candidates completed this step, even if the further calculation was incorrect. Most candidates did then recognise that, as the units required were g/dm^3, the value of 58.2 needed to be divided by 0.1 (as $100 cm^3$ of water was used), giving a final answer of $582 g/dm^3$.

(iii) A minority of candidates successfully answered this question by stating that there was always a higher value for solubility because some of the solid did not dissolve. Most candidates gave a variety of other reasons to do with heat loss or gain, or the amount of stirring. While the amount of stirring may affect the results, it would not necessarily always give a 'higher value for the solubility' as specified in the question. Candidates should have looked carefully back at the question stem and recognised that step 6 referred to 'a small amount of undissolved solid'. The presence of this would always give a higher value for solubility than the true value.

(b) Most candidates correctly estimated the solubility of ammonium chloride at 20 °C to be 390 g / dm^3.

(c) Approximately half of the candidates correctly realised that this method could not be used for determining the solubility of ammonia because ammonia is a gas.

Question 2

(a) The majority of candidates correctly calculated the number of moles of hydrochloric acid added to the beaker as 0.025.

(b) (i) Candidates completed a table of titration volumes using the readings shown in the diagram. The majority of candidates did this successfully. The most common error was when ticking the best titration results. Candidates should realise that the 'best' titration results are those that are concordant or closest. If the correct values of 18.1 and 2.4 were put in the table, the volumes used would be 15.7, 15.2 and 15.4, and the 'best' of those are the two concordant ones, 15.2 and 15.4.

(ii) Most candidates correctly calculated a mean from their ticked values. If the values from the diagram were read correctly, the mean was 15.3.

(c) Using the mean volume of 0.100 mol / dm^3 sodium hydroxide from **(b)(ii)**, candidates had to calculate the number of moles of sodium hydroxide that react with 25.0 cm^3 of **B**. The correct value, which most candidates obtained, was 0.00153.

(d) In this question candidates had to use the answer to **(c)** to calculate the number of moles of sodium hydroxide that would react with 100 cm^3 of **B**. The answer to**(c)** gave the number of moles in 25 cm^3. Half of candidates realised that all that was needed to calculate the number of moles in 100 cm^3 was to multiply their answer to **(c)** by 4. The correct answer was 0.00612.

(e) Approximately half of candidates were successful in this question. The question signposted candidates to use their answers to **(a)** and **(d)** to calculate the number of moles of hydrochloric acid that react with calcium carbonate in the sample of **A**. The first sentence in the question stem of **(e)** tells candidates that the answer to **(d)** is equal to the number of moles of hydrochloric acid that remain in the beaker after the acid reacts with the calcium carbonate in **A**. Looking back to **(a)**, candidates are asked to calculate the number of moles of hydrochloric acid added to the beaker. Therefore, the number of moles of hydrochloric acid that have reacted is the difference between the two values, **(a)** – **(d)**. Using the correct values, this would be 0.025 – 0.00612 = 0.01888.

(f) Just under half of candidates answered this correctly and those that performed had carefully read the question to determine what was being asked. The key was to understand what had just been calculated. In **(e)**, the number of moles of hydrochloric acid that had reacted was calculated. This question then gives the equation for the reaction, showing that the ratio of acid to base is 2 : 1. To determine the number of moles of calcium carbonate, candidates had to halve their value from **(e)**. The correct answer is 0.00944.

(g) (i) A minority of candidates recognised that the reason for mixing the reactants by stirring was to make the reaction faster.

(ii) Careful reading of the whole of the question was again needed. The question asked why the candidate should wait for the effervescence to stop. A large number of candidates incorrectly stated that it would show that 'all reactants' have been used up, or that the 'acid' has been used up. In **(c)**, it clearly states that the acid used to prepare **B** is in excess. Any indication from the candidates that the acid has been used up was therefore incorrect. Approximately a third of the candidates recognised this and stated that the calcium carbonate had been used up, or that the reaction was complete (with no indication that the acid had been used up).

(h) Candidates were asked to explain why using a measuring cylinder makes the volume of hydrochloric acid used inaccurate and to give an improvement. Most candidates were successful and indicated that the measuring cylinder would not be precise enough or would have a low resolution. Some candidates did not achieve credit as they merely repeated the question, saying that a measuring cylinder is inaccurate. Most candidates gave an appropriate improvement, such as using a burette or pipette.

(i) The key to this question was to be specific. Most candidates recognised that if water remained in the burette the titration result would be changed, but this was not enough to achieve credit. The most successful candidates stated that if water remained in the burette, the sodium hydroxide would be diluted by the water.

Question 3

(a) (i) The better performing candidates recognised that this question was related to the displacement reactions of halogens. A number of candidates incorrectly related this to the silver nitrate tests for halide ions. This resulted in many candidates giving the same answer for **(a)(i)** and **(a)(ii)**, which could have been an indication to candidates that a different direction was needed here. The clue that it was to do with the halogen displacement reactions, is that in the question stem it states that aqueous chlorine is added to **W**. From looking at the ‘Notes for qualitative analysis’, candidates could see that none of the tests start with ‘add aqueous chlorine’, therefore this question must be related to other reactions. The correct answer was to state that a red-brown solution would be formed, as chlorine displaces iodine. As with **Question 2(i)**, candidates had to be specific here. Some candidates realised the reaction they were being asked about, but simply stated it was because ‘chlorine is more reactive than iodine’. This was not enough to explain why the solution changed colour, some mention of displacement, or of iodine being produced was needed.

(ii) This question was completed successfully by most of the candidates, simply by using their ‘Notes for qualitative analysis’. Candidates had to refer to the addition of dilute nitric acid and aqueous silver nitrate and then that a yellow precipitate would be formed.

(b) Candidates had to describe how a flame test was carried out on solution **W**. Most candidates stated that a splint or wire should be dipped into **W**. Most candidates did then mention placing this in a flame, but fewer candidates specified that it should be held in a blue, or roaring Bunsen burner flame.

(c) Approximately half of candidates were successful on this question and stated that **W** would be potassium iodide. A number of candidates just said ‘potassium’. As in earlier questions, careful reading of the information would have informed the candidates that **W** could not be potassium, as at the top of the page, it says that **W** is an aqueous solution. In **(a)(i)**, it says that **W** contains iodide ions. All information needs to be considered before giving the answer.

(d) This question needed careful reading of the stem, which describes adding sodium hydroxide to **X** and warming it. The candidates could have looked at the ‘Notes for use in qualitative analysis’ to identify that the test described is for ammonium ions. The question stem then says that damp red litmus paper held above the test-tube did not change colour. Again, the candidates could have looked at the ‘Notes for use in qualitative analysis’ and found that this would mean that no ammonia was produced, so no ammonium ions would have been in **X**. The final bit of relevant information from the question stem was that a white precipitate, soluble in excess sodium hydroxide was formed. Looking at the ‘Notes for use in qualitative analysis’ would indicate that this is the result expected if either aluminium ions or zinc ions are present. Just under half of the candidates answered this successfully, by indicating that aluminium ions or zinc ions are present, and that ammonium ions are not present. A number of candidates incorrectly stated that ammonium ions were present; careful reading of the question stem would have avoided this error.

(e) Candidates were asked to describe a further test that could be carried out to identify the cation in **X**. Successful candidates realised that, as the sodium hydroxide test had already been described, they needed to describe the cation test with aqueous ammonia. The 'Notes for use in qualitative analysis' could have been used here to give the ammonia test and results for aluminium ions and zinc ions. Candidates needed to state that ammonia should be added until in excess that aluminium ions would give a white precipitate which is insoluble in excess. They should have said have also noted that zinc ions would form a white precipitate, soluble in excess. A number of candidates copied the information from the 'Notes for use in qualitative analysis' correctly, but did not indicate which result would have been for each ion.

(f) (i) The question stem describes the test for nitrate ions and the test for ammonia gas. Both parts of **(f)** could have been answered by using the 'Notes for use in qualitative analysis'. Most candidates did this successfully. The correct answer to **(i)** is to state that the red litmus paper goes blue.

(ii) The anion in **X** was correctly identified by most candidates as nitrate.

Question 4

A reoccurring theme in candidate performance in this exam was the need for the candidates to carefully read and understand the question stems. This was particularly relevant in **Question 4**. The stem describes a mixture **Q**, consisting of magnesium oxide and barium sulfate. It describes how magnesium oxide reacts with hydrochloric acid to give soluble magnesium chloride, whereas barium sulfate does not react with hydrochloric acid and remains insoluble. Candidates are asked to plan an investigation to obtain pure magnesium chloride crystals and pure barium sulfate solid. A key part of the information given is that they are asked to describe the use of common laboratory apparatus, dilute hydrochloric acid and **Q** only. It specifies that no other chemicals should be used. Ideal answers described adding excess hydrochloric acid to **Q**, then filtering (using a conical flask, filter funnel and filter paper). The filtrate would then be heated (using a Bunsen burner) until saturated and left to cool, giving the magnesium chloride crystals. The residue would be washed and dried to obtain barium sulfate solid. The very best responses then realised that they also had to describe a test to show that the barium sulfate is pure, stating that the melting point of the solid should be determined.

The question stem gives five bullet points that should be included in the plan. There were marks for each of these sections. If a candidate missed a section, then full credit could not be attained. A number of candidates did not specify the names of the apparatus that was used, so missed out the first bullet point. In general, the descriptions of the techniques of filtration and crystallisation were well done by most. Some candidates described the processes using separate samples of magnesium oxide and barium sulfate. The question stem was very clear – hydrochloric acid and **Q** were the only chemicals available. Therefore, candidates that spoke about the addition of separate magnesium oxide and barium sulfate did not attain full credit. Many candidates did not describe how to test the purity of the barium sulfate (bullet point five).

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Paper 5070/42
Alternative to Practical

Key messages

- It is important that candidates have as much opportunity as possible to actually do or see experiments rather than learning from descriptions and past papers. This makes it much easier for them to relate to the practical contexts referred to in the questions and is particularly important when it comes to the planning question.
- Candidates should also be familiar with the tests for quantitative analysis and how to use this both to plan experiments and interpret experimental observations.

Comments on specific questions

Question 1

(a) (i) Few candidates recognised the need to measure room temperature.

(ii) A wide range of mass was allowed and most candidates were able to select a value within this range. There were a variety of different ways that candidates could use to calculate a suitable value.

(iii) Few candidates recognised that leaving a solution which is at 75 °C at room temperature will result in a cooling of the solution. More candidates recognised that the solid forms due to crystallisation of the potassium nitrate because of the difference in solubility between 75 °C and room temperature.

(b) A common mistake was to state that the solution boils at 115 °C rather than that it starts to boil at or just above 100 °C as this is the boiling point of water.

(c) Very few candidates noted from the method that there is undissolved potassium nitrate left in the solution which will add to the apparent mass dissolved. A lot of candidates wrote answers linked to temperature loss or gain.

Question 2

(a) Most candidates recognised that tap water contains a variety of different dissolved substances. Candidates could gain credit if they suggested any reasonable type of substance that would be dissolved in tap water. Alternatively, some candidates referred to the purity of distilled water.

(b) (i) Most candidates read the two volumes correctly from the diagrams. Some candidates made incorrect subtractions from the data. More candidates found it difficult to identify the best titration results. At this level, candidates are expected to know that results may be considered accurate if they are within 0.2 cm^3 of each other. They could also identify the best results by selecting the ones which are closest to each other. Some candidates chose to tick just one result when there is no way to identify a single best result from the data provided.

(ii) The answer to this part was based on the values that the candidate chose to tick in **(b)** rather than as an absolute answer.

(c) This calculation was dependent on the candidate selecting correct values from the method rather than from their own results. Many candidates were able to do this calculation.

(d) Candidates could obtain this mark by using the correct answer or by obtaining a different answer using their result for **(c)**. Many candidates recognised from the equation that they simply needed to divide their answer from **(c)** by three.

(e) Very few candidates recognised the need to use their experimental result in this calculation. A common error was to suggest that the answer to **(e)** was the same as **(d)**.

(f) This calculation was straightforward and many candidates showed they knew how to do the calculation. Some candidates recognised that they needed the number of moles of H_3A to do this calculation and if they could not do **(e)**, they chose any number, e.g. 1, as their answer to **(e)** so that they could then multiply this by 210 to obtain an answer in **(f)**.

(g) Candidates generally repeated the question by saying that measuring cylinders were not accurate. Few candidates were able to give a reason for this lower accuracy by referring to the precision of the scale on the measuring cylinder. Some candidates thought that a 100 cm^3 measuring cylinder was able to measure to the nearest 0.1 cm^3. Far more candidates were aware that a burette, volumetric pipette or volumetric flask was more accurate.

(h) (i) Although many candidates referred to impurities in the burette, they did not always explain that the purpose of the distilled water is to remove these impurities.

(ii) Candidates' answers were often vague. The question specifically asks for the effect on the titration results so it was necessary to state that the titration result would be greater than it should be. More candidates were able to explain that the effect was a result of the distilled water diluting **X**.

Question 3

(a) (i) Many candidates were unable to explain how to do a flame test. Firstly, the question specifically asks for a test on the solid so candidates should not have referred to solutions. Secondly, although there are a variety of techniques that can be used, using a spatula, test-tube, beaker or copper wire to introduce the solid into the flame is not acceptable. The best technique is to use a nichrome or platinum wire but, at this level, using a dampened splint is a suitable alternative. Thirdly, very few candidates referred to the essential requirement of using a Bunsen burner with the air hole open. A yellow flame from a Bunsen burner or the use of a spirit burner is not suitable for a flame test as the yellow colour masks the colour caused by the metal ion.

(ii) Despite the poor responses to **(a)(i)** most candidates were able to identify copper ions as the cause of the blue-green colour.

(b) (i) The stem of the question tells candidates that solid **A** is a carbonate so they should have been able to obtain some of credit by referring to the notes for quantitative analysis. Generally, candidates performed well but only the better performing candidates recognised that the solid would react to form a blue/blue green solution. Knowing that copper is a transition metal, they should have known that a coloured solution would form even if they were not familiar with the exact colour.

(ii) Most candidates recognised that effervescence would stop when the reaction was finished, even those candidates who did not give effervescence/fizzing as an observation in **(b)(i)**.

(c) Candidates performed well on this question. Three of the four marks could be obtained by applying the notes for quantitative analysis to the context of the question. The ability to apply these notes to specific practical contexts is an important skill that is assessed in this paper. Candidates who performed less well either were confused by the question and thought that ammonia was being produced or were too vague and talked about the use of aqueous ammonia to identify cations in general terms. The question specifically asks candidates to include the observations they expect. They needed to refer to their answer in **(a)(ii)** and describe the results that this cation gives. If they suggested an incorrect cation in **(a)(ii)** they could still gain credit here if their answer was correct for their named cation.

(d) This question tested the ability of the candidate to identify an anion from a variety of test results. This is more in keeping with actual practical work than questions which give only one result from which to draw a conclusion. Many candidates were able to do this correctly but a number suggested sulfate, nitrate, chloride or iodide. Some suggested sulfate, bromide and nitrate were present. Some candidates contradicted themselves by naming bromine rather than bromide but gave a correct formula for the ion. This does not gain credit as candidates are expected to know the difference between bromine and bromide.

Question 4

Many candidates followed the structure of the question and attempted to address each bullet point in turn, which often means that they do not miss out key information.

A significant number of other candidates did not understand the question. The opening statement tells them that **Q** is a mixture. They should not, therefore, be doing experiments with separate samples of copper(II) carbonate and lead sulfate. Candidates who did this could not obtain full credit.

Some candidates did not name key pieces of apparatus needed in their method. This is specifically asked for.

Only the best responses were aware of the need to use excess sulfuric acid to ensure that all of the copper(II) carbonate had reacted before they filtered the mixture.

Only the better performing candidates knew that a melting point test is used to show the purity of a solid. Most candidates either thought that washing the sample proved it was pure or that doing some form of anion or cation test proved it was pure.

Weaker responses often muddled up the names of chemicals in their description, particularly misusing the names of copper(II) carbonate and copper(II) sulfate.

The addition of sulfuric acid had to be described in the correct context of adding it to **Q**. Adding acid to separate solids was not credited.

Filtration also had to be described in the correct context. The mixture of Q and acid had to be filtered and not for filtering the copper(II) sulfate crystals from any remaining filtrate after crystallisation. Filtering after adding acid to just copper(II) carbonate was not credited as there would be no residue to separate.

Heating the filtrate to dryness and hence obtaining anhydrous copper(II) sulfate was not acceptable.

Marks were credited from diagrams where this was appropriate.