CHEMISTRY

Paper 5070/11
Multiple Choice

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

General comments

Question 4 and **Question 17** were found to be easy.

Question 32 and **Question 36** were found to be challenging. There was evidence of large scale guessing in **Question 31** and **Question 36**.

Comments on specific questions

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

Question 8

Option **B** was chosen by almost as many candidates as the key. Option **B** is the total number of constituent atoms in the sample and not the number of ions formed by those constituent atoms.

Question 9

Almost half of the candidates chose option **D**, the sample with the largest amount of molecules, rather than the largest amount of constituent atoms.

Question 12

Option **A** was chosen by almost as many candidates as the key, option **B**, and most candidates chose either option **A** or option **B**. The difference in the options was whether copper can be electrolysed. Candidates perhaps thought that the metallic nature of copper and its high electrical conductivity meant it could be electrolysed.

Question 18

Option **D** would normally be correct, but candidates ignored the data. Some e candidates chose option **A** in preference to the key. This does give the mass of aluminium that reacts, but not the mass of aluminium added. Also, the stem of the question states that the aluminium is in excess.

Question 24

Some candidates chose option **C** rather than the key, option **A**. These candidates ignored the significance of in excess in the prompt.

Question 25

There was some evidence of guessing. Options **A** and **D** were commonly chosen. These candidates did not have knowledge of solubility rules in 7.3.3 of the syllabus. Also, option **D** has the use of concentrated sulfuric acid and the prompt states preparation in a school laboratory.

Question 31

There was evidence of guessing. These candidates did not have sufficient knowledge of the reactions in 9.6.3(b) and (c) of the syllabus.

Question 32

More candidates chose options **A** and **B** rather than the key. The stem states that the fertiliser has to have pH 7. Candidates did not use knowledge of acidity of oxides from 7.2.2 of the syllabus to rule out the use of (acidic) phosphorus oxide or alkalis from 7.1.1 to rule out the use of (alkaline) potassium hydroxide.

Question 36

More candidates chose option **B** this rather than the key, option **D**. Candidates did not have sufficient knowledge of the reactions in 11.4.4 of the syllabus to rule out reactions 1 and 2. Option **C** was also chosen by some candidates.

Question 39

Candidates choosing option **B** divided the values on the ruler for the solvent front, 16, and the baseline, 4, rather than (8–4) divided by (16–4).

CHEMISTRY

Paper 5070/12
Multiple Choice

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

General comments

In **Question 14** and **Question 24**, candidates chose an incorrect option more frequently than the key.

Comments on specific questions

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

Question 4

Options **B** and **D** were common incorrect chooses. There was also some evidence of guessing by candidates. This is likely to be a result of not being able to apply skill in 2.3.4 of the syllabus to this sample with masses given as x and $x + 2$ rather than values for the different relative atomic masses of the isotopes.

Question 5

Some candidates selected option B, perhaps thinking that there are two carbon–oxygen single bonds in the molecule.

Question 10

Option **B** was chosen by some candidates. This is the percentage yield which uses a 1 : 1 reaction stoichiometry rather than the 2 : 1 given in the equation. There was also evidence of guessing by some candidates.

Question 11

Candidates show selection option **A** had identified the two correct arrows showing movement of electrons in the external circuit, but incorrectly identified the movement of electrons in the electrolyte. These candidates did not have good knowledge of 4.1.3(c) of the syllabus.

Question 12

The choice of option **B** would have been the correct response if the electrodes were both inert, however the stem specifies the use of copper electrodes. There is some evidence of guessing by some candidates.

Question 14

Option **B** was chosen by just over half of the candidates. Candidates correctly identified that energy is absorbed from the surroundings in an endothermic reaction, but then incorrectly thought that this results in a rise in the temperature of the reaction mixture.

Question 24

More candidates chose option **C** than the key, option **B**. These candidates did not have a good understanding of the term water of crystallisation, 7.3.5 of the syllabus.

Question 31

Candidates choosing option **C** only considered the phosphorus in the ammonium phosphate and not the nitrogen.

Question 32

Candidates choosing **C** did not understand that the displayed formulae, as described in 11.1.2 of the syllabus, of structural isomers cannot be the same.

Question 33

This item tests a common misunderstanding. Candidates choosing option **C** did not take into account the carbon atom in the ester functional group when deducing the length of the carbon chain in the carboxylic part of the ester. This then leads to the incorrect naming of the ester, in this case a propanoate rather than correctly, a butanoate.

Question 36

It is likely that candidates choosing option **C** considered the amount of oxygen required to form carbon dioxide only and not water. There is evidence of guessing by some candidates.

CHEMISTRY

Paper 5070/21
Theory

Key messages

- Better performing candidates showed their working out in calculations. This allows answers which are incorrect to gain credit as error carried forward.
- Candidates need more practice constructing balanced equations, including use of state symbols.
- Many candidates did not understand the drawing of structures of organic compounds.
- It is important that candidates use the correct scientific terminology e.g. iodine and iodide in **Questions 4(c)** and **4(e)**.
- In equilibrium questions, it is the position of equilibrium which moves and not the reaction.
- Candidates need to read questions carefully so that they answer what is being asked e.g. **Question 2(c)(iii)** where the colour change needs both the starting and ending colours, **Question 3(a)** where the question asked for the answer to two significant figures and **Question 7(b)** where the question asked for changes not for the properties of a solid or a gas.

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.

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

Candidates found questions assessing organic chemistry challenging.

Comments on specific questions

Question 1

(a) The catalyst in the Haber process was well known. Incorrect responses included catalysts for different processes i.e. vanadium(V) oxide and nickel.

(b) Most candidates chose the giant covalent structure. Iron was the most common incorrect response.

(c) The majority of candidates chose hydrated copper(II) sulfate. The most common incorrect response was magnesium sulfate.

(d) The use of carbon in the treatment of water was not well known. The most common incorrect response was chlorine; some gave vanadium(V) oxide.

(e) Better performing candidates deduced the empirical formula correctly. Most chose either methanol or methanoic acid since these both contain one carbon atom.

Question 2

(a) Better performing candidates gave a correct symbol equation. Many incorrect responses had the formula of calcium hydroxide as CaOH or CaO.

(b) Just over half of the candidates deduced the correct formula. Incorrect responses included C_2^-, C^{2-}, C^{2+} and C^+.

(c) (i) Whilst many candidates appreciated that the hydrocarbon consisted of C and H, many did not indicate their exclusivity.

(ii) Unsaturated was quite well known. Common incorrect responses included: 'double bond present' without qualifying with C-C, 'reactive', 'contains more than one bond' and 'contains no water'.

(iii) Many candidates appreciated that bromine went colourless, but many omitted the starting colour. Reversing the colour change was also seen.

(iv) About half of the candidates drew a correct dot-and-cross diagram. Incorrect responses included: single bond between carbons, double bond between carbons, non-bonding electrons on carbon or hydrogen or both and the molecule C_2H_4. A significant number omitted the question.

(d) (i) Candidates found this challenging. Many discussed the reaction being exothermic due to bonds being made, omitting bonds being broken. A significant number incorrectly discussed energy being needed or used to make bonds.

(ii) Many candidates drew a fully correct reaction pathway diagram. Those who drew an endothermic pathway could gain some credit as error carried forward. The most common error was to draw either an upwards arrow or a double headed arrow for ΔH. Responses frequently lacked the precision required where arrows needed to start and end in the correct places i.e. from reactant line to the product line or from the reactant line to the top of the activation energy hump. Many arrows were far too short.

Question 3

(a) Many candidates calculated the volume of nitrogen correctly, however, many did not quote their final value to two significant figures. Other errors included dividing by 24 instead of multiplying and using 25 instead of converting to dm^3 and using 0.025.

(b) Many candidates gained at partial credit. Often an increase in kinetic energy was discussed with no reference to particles and the effect on the rate was frequently omitted. Other non-creditworthy responses included more collisions or more frequent collisions rather than more of the collisions being successful.

(c) This proved very challenging and only the better performing candidates gained credit. This was often due to incomplete answers which lacked clarity. Less reactant, less particles and less successful collisions were common non-creditworthy responses.

(d) The use of universal indicator was not well known. Many who gave universal indicator also gave an example as methyl orange or litmus. Many gave just 'indicator' without specifying which. Comparing the colour obtained to a pH colour chart was not well known. Many linked a colour to a pH or simply said different pHs gave different colours.

Question 4

(a) Candidates found this very challenging. Some answers lacked detail such as 'strong ionic bond' unqualified or 'strong forces between ions' with no reference to attractive or opposite charges. However, many candidates discussed intermolecular forces between the ions.

(b) Many candidates appreciated that each calcium atom would lose two electrons to form a calcium ion. Some thought the ion would lose electrons or did not specify the number of electrons being lost. However, it was iodine that candidates found the most difficult. The question asked about iodine molecules hence references to iodine in a response was taken to mean iodine molecules. Many candidates had iodine (molecules) gaining one electron and not two rather than specifying that the iodine atom gained one electron. Some had iodide gaining an electron.

(c) Better performing candidates predicted the products correctly. Some reversed the products. Common incorrect responses included: for the anode I^-, K and K^+ and for the cathode K, K^+ and H^+. It is good examination practice to only give the information required by the question; some candidates gave incorrect equations which were not creditworthy.

(d) The colour change was not well known. Some reversed the colour change, only gave the colour change for the potassium manganate(VII) or the reverse of the colour change for potassium manganate(VII). Some gave the two correct colour changes separately.

(e) Many candidates gained partial credit usually for chlorine. The most common error was iodine losing electrons rather than iodide. Some candidates reversed the gain and loss of electrons of redox.

Question 5

(a) The change and reason were quite well deduced. A significant number had the equilibrium moving to the left. Some gave the reaction moving to the right, which is not creditworthy; it is the position of equilibrium which moves. 'Favouring the right' is also not creditworthy. Where the reaction is discussed, by convention this means the forward reaction. Candidates aften discussed the reaction being exothermic instead of the reverse reaction being exothermic.

(b) Candidates found this challenging with many giving the equilibrium moving to the left or staying the same. **'**Reaction moving' or 'equilibrium favouring' are not correct. Many knew that there were fewer moles on the left-hand side but omitted to discuss moles of gas. A significant number thought the moles on each side were the same.

(c) Many candidates calculated the mass correctly. Common errors included 97 for the M_r of zinc sulfite, calculating the amount of zinc sulfite as 25.5 × M_r of zinc sulfite and calculating the mass of zinc oxide by dividing the amount of zinc sulfite by the M_r of zinc oxide. A significant number omitted the question.

(d) Candidates found this challenging. Many rewrote the question stem. Many discussed zinc oxide being more reactive than HC*l* and sulfur dioxide being less reactive than HC*l*. Those that gave zinc oxide as amphoteric often described sulfur dioxide as not amphoteric rather than acidic. A significant number omitted the question.

(e) Better performing candidates gave a correctly balanced equation. Many gave the products as Zn, ZnO, ZnOH or $ZnNO_3$. Many gave no state symbols, only state symbols for some of the species, nitric acid as a liquid or zinc nitrate as a solid.

Question 6

(a) The adverse effects of increased global warming were quite well known. Non-creditworthy responses included temperature increasing and ice melting.

(b) The mechanism of how carbon dioxide causes global warming was not well known. Many discussed destruction of the ozone layer or carbon dioxide trapping light from the Sun. Other incorrect responses included the effects of global warming such as rising sea levels etc. or CO_2 becoming CO which is poisonous.

(c) (i) The equation for photosynthesis was well known. Incorrect responses included reversing the equation, using O instead of O_2 and CH_2O for glucose.

(ii) Whilst most candidates knew that light was needed, far fewer appreciated the need for chlorophyll.

(d) The majority of candidates knew a strategy for reducing global warming. Incorrect responses tended to be too vague such as regulate factories or do not let carbon dioxide escape. Some gave electric cars which does not consider how the electricity is generated for charging these cars.

Question 7

(a) Better performing candidates appreciated the outcome of increased pressure. Many thought the increased pressure would make the particles move faster or have more collisions and so would increase the volume of the gas.

(b) The majority of candidates either discussed all three aspects for a solid or a gas or gave the separation as increasing. Most did not appreciate that to discuss a change, both solid and gas should be addressed.

(c) The factor affecting the rate of diffusion was quite well known by better performing candidates. Careless use of terminology was often seen including 'lower mass', 'lighter', 'light', 'lower molar mass' and 'lower relative atomic mass'. Some thought it was due to chlorine's higher reactivity.

(d) Deducing the numbers of particles from an ion symbol was well answered by most candidates. Incorrect responses for electrons included 53 and 126; for neutrons included 53, 126 and 172 and for protons included 54, 73 and 126

Question 8

(a) (i) Better performing candidates named the alcohol. The most common response was propanol. A small number of 1-propanol was also seen.

(ii) The structure of the isomer was quite well deduced. The most common incorrect responses were to draw the straight chain isomer, just drawing it going round a corner and not displaying the O-H bond.

(b) Better performing candidates drew the ester. The acid was a common incorrect response. Other responses appeared to be guesses of structures which could never exist. A significant number omitted the question.

(c) Just under half of candidates gave a correct structural formula. The most common incorrect response was butanoic acid. A significant number omitted the question.

(d) Candidates found this very challenging and a significant number omitted the question. Incorrect names included magnesium, magnesium oxide, magnesium propanoic acid or water. Incorrect structures included $(C_3H_4O_2)_2Mg$, $C_3H_7O_2)_2Mg$, C_2H_5COOMg, Mg, MgO or H_2O. A significant number omitted the question.

(e) The gases were well known. Incorrect responses for **E** included carbon monoxide and carbon and for **F** included water and oxygen. A significant number omitted the question.

(f) Almost half of candidates named the ester correctly. Incorrect responses included: 'ethne', 'ethene', 'butyl ethanoate', 'propyl ethanoate', 'ethanoic acid' and 'pentanoic acid'. A significant number omitted the question.

Question 9

(a) The differences between polymers were not well known. A common incorrect response was 'addition is adding to make a polymer' and 'condensing is taking away to for a polymer'. Other incorrect responses included for condensation 'decomposing to make a polymer' and 'adding water'. A significant number omitted the question.

(b) Better performing candidates named the linkage correctly. Amide was the most common incorrect response. A significant number omitted the question.

(c) The majority of candidates calculated the empirical formula correctly. Incorrect responses included using the M_r of hydrogen and/or chlorine, inverting the fraction for calculating the number of moles and incorrect use of a calculator.

(d) The environmental challenges were quite well known. Often responses only included generic answers such as 'air pollution', 'water pollution', 'land pollution', 'animals choking' and 'harmful gases.'

CHEMISTRY

Paper 5070/22
Theory

Key messages

- 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.
- Candidates need to check that blank spaces within the question paper are actually spaces and not answer spaces where either calculations or drawings should be inserted.

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 show sufficient working out so it was not always possible to award credit for error carried forward.

Candidates found balancing equations difficult, often because they wrote down incorrect formulae which made the balancing impossible.

Comments on specific questions

Question 1

Almost all the candidates followed the rubric and gave the formula of the oxide rather than the name.

(a) Vanadium(V) oxide was well known as the catalyst used in the Contact process.

(b) Many candidates were unable to recognise the reducing agent in the blast furnace. Common incorrect answers included other compounds found within a blast furnace such as silicon(IV) oxide and calcium carbonate.

(c) Many candidates recognised anhydrous copper(II) sulfate

(d) Chlorine was well known for its use in the treatment of the domestic water supply.

(e) Candidates found this question about empirical formula very challenging. The most popular incorrect answers were methanol and methanoic acid.

Question 2

This question was about the chemistry of methane.

(a) Candidates found writing the symbol equation very challenging. Candidates often could not write the correct formula for aluminium hydroxide, A*l*OH and A*l*OH_3 being popular incorrect formulae.

(b) (i) Many candidates were able to explain why methane is a hydrocarbon. The most common misconception was to refer to only hydrogen and carbon bonds.

(ii) Many candidates gave the standard explanation about the presence of only carbon–carbon single bonds but did not relate the question to methane which does not have any carbon–carbon bonds. The best answers stated that all the bonds were single bonds.

(iii) Candidates often gave the names of products rather than the formulae and often the names were incorrect. Candidates who gave HC*l*(aq) were not given credit since HC*l*(g) is formed. Hydrogen was a common incorrect answer often associated with the correct answer $CH_2C\mathit{l}_2$. The most common correct answers were $CH_3C\mathit{l}$ and HC*l*.

(iv) The dot-and-cross diagram for methane was well known and hardly any candidate gave an ionic structure. The most common misconception was to include extra lone pairs on carbon and/or hydrogen.

(c) (i) A significant proportion of candidates were able to give a good explanation. The most common misconception was that energy is used to make bonds. Other candidates referred to energy lost or energy gained but did not give any indication if this was the surroundings or system gaining or losing energy. Other incorrect explanations referred to the number of bonds made and broken but did not compare the thermal energy involved.

(ii) Many candidates were not awarded credit since the two energy changes on their diagram were not sufficiently clear. Some candidates muddled up the position of the reactants and products both in terms of height and horizontal position in the diagram. Candidates should be advised to use an arrowhead on the energy change lines making sure the arrowhead is in the correct direction.

Question 3

This question was about aqueous hydrogen peroxide.

(a) The best answers worked out the amount in mols of hydrogen peroxide and then deduced the amount in moles of oxygen. The molar volume was then used to calculate the answer of 0.11 dm^3. Many candidates did not quote their answer to two significant figures and others were not able to calculate the amount in mols of hydrogen peroxide because they did not convert the volume into dm^3. A significant proportion of the candidates tried to use the molar mass of hydrogen peroxide when it was inappropriate.

(b) The effect on the rate of reaction was well known but some candidates tried to explain their answers using ideas about chemical equilibria. The idea that kinetic energy decreases was often mentioned but not always linked with particles. Good answers often referred to less energetic or less successful collisions. Only a very small proportion of the candidates referred to activation energy arguments.

(c) The effect on the rate of reaction was well known but some candidates tried to explain their answers using ideas about chemical equilibria. The incorrect idea that kinetic energy increases was sometimes mentioned. Good answers often referred to more crowded particles or more particles per unit volume and then related this to an increase in collision frequency.

(d) (i) The hydrogen ion was mentioned by many candidates with only a very small proportion of the candidates referring to the peroxide ion. Both the formula and the name of the ion were accepted.

(ii) Candidates often mentioned universal indicator, but a significant proportion of the candidates gave other indicators such as litmus or methyl orange. The use of a colour chart was sometimes given but often there was just a link between one colour and its pH value.

Question 4

This question was about calcium bromide and redox reactions.

(a) The idea of strong ionic bonds was not sufficient to be awarded credit. Candidates needed to refer to strong attraction between positive and negative ions. The best answers also mentioned that this strong attraction needed lots of thermal energy to overcome.

(b) Candidate found this question challenging and often gave imprecise answers because they did not specify which particles they were using. Candidates had to be clear they were referring to a calcium atom losing 2 electrons and a bromine molecule gaining two electrons. Many answers just referred to bromine gaining an electron without specifying whether the bromine particle was an atom or a molecule.

(c) Typically, candidates got one product correct but not both of them. With dilute aqueous halides the products are the halogen and hydrogen. Some candidates gave calcium and bromine as the product.

(d) (i) The colour change from colourless to brown was often given but some just gave the end colour. Other candidates gave purple as the final colour.

(ii) Candidates often gave the correct colour change of purple to colourless.

(e) Candidates were often imprecise about the identity of particles involved. Bromine gains electrons did not gain credit because in the equation it is bromide ions that gain electrons. Candidates were more likely to be awarded credit for ‘chlorine is reduced since it gains electrons’. Many candidates showed understanding that reduction involves gain of electrons and oxidation the loss of electrons.

Question 5

This question was about zinc carbonate.

(a) A significant proportion of the candidates did not write about the position of equilibrium and instead wrote about which reaction was favoured. Other candidates referred to the reaction shifting rather than the position of equilibrium shifting. Candidates often appreciated that the position of equilibrium moved to the left because the forward reaction was endothermic. Centres should advise candidates to specify if the exothermic or endothermic reaction is the backward or forward reaction to avoid confusion.

(b) A significant proportion of the candidates did not write about the position of equilibrium and instead wrote about which reaction was favoured. Candidates often gave an explanation based on number of moles of reactant and product but then forgot to mention that it is the moles of gas that is important.

(c) Many candidates gave an answer within the tolerance accepted. Most correct answers used a mole approach rather than a mass ratio approach, however, the working out shown was not always very logical. Some candidates confused the two zinc compounds and as a result used incorrect molar masses.

(d) Some candidates explained that zinc oxide was amphoteric and carbon dioxide was acidic. Other answers tried to compare sodium hydroxide and hydrochloric acid in terms of a reactivity series.

(e) The formula for zinc nitrate and nitric acid were not well known and as a result candidates found this question extremely challenging. Credit for the state symbol marks was only awarded if the formulae were correct. Common misconceptions included $HNO_3(l)$ and $H_2O(aq)$.

Question 6

This question was about air pollutants.

(a) Many candidates recalled that an adverse effect of methane was climate change or global warming. Some candidates thought methane was toxic or caused ozone depletion.

(b) Candidates often gave one strategy to reduce sulfur dioxide emissions. Typically, this was to use less fossil fuels or flue gas desulfurisation. Candidates often referred to sulfur dioxide-free fuels rather than sulfur-free fuels and implied that the sulfur dioxide was always in the fuel as opposed to sulfur in the fuel making sulfur dioxide on combustion. Two common misconceptions were to use a catalytic converter to remove sulfur dioxide or burn the fuel in a closed system to stop sulfur dioxide entering the air.

(c) (i) The use of a catalytic converter was well known but the actual chemistry involved was often incorrect. Some candidates involved converting nitrogen monoxide into nitrogen dioxide rather than reducing it to nitrogen. Many answers had symbol equations, but the question only asked for a word equation. Either the decomposition of nitrogen monoxide or reaction of nitrogen monoxide with carbon monoxide were accepted in the word equation.

(ii) The adverse effects of oxides of nitrogen were quite well known and included smog, respiratory problems, ozone depletion and global warming. Some candidates gave answers more appropriate for carbon monoxide such as toxicity.

Question 7

This question was about oxygen and sulfur.

(a) A significant proportion of the candidates appreciated that the volume increases but found the explanation more challenging. Many candidates referred to kinetic energy increasing and particles moving faster. Candidates rarely focused on the increase in molecular separation e.g. particles moving further apart.

(b) Candidates found this question very challenging. Some candidates did not appreciate it was about the change from a gas to a solid and just described the particle arrangement either in a solid or in a gas. Candidates did not understand the term separation and often gave a method of separation. Some candidates did appreciate that the particles slowed down or had less kinetic energy. Many candidates did not refer to a solid having an ordered arrangement and thought that a fixed arrangement meant an ordered arrangement.

(c) Many candidates gave accurate descriptions for diffusion.

(d) Candidates often got at last two entries correct in the table, typically the number of protons and/or the number of neutrons.

Question 8

This question was about some organic reactions.

(a) Many candidates gave a displayed formula that was not completely displayed because the hydroxyl group was written as –OH. Centres should advise candidates that in displayed formulae all the atoms and all the bonds must be shown. Some candidates drew butan-2-ol instead. A small proportion of the candidates did not attempt the question.

(b) Candidates needed to give the exact name of the ester with no errors of spelling. It is important that the name is written clearly, and incorrect answers are crossed out and replaced with the correct answer. Some candidates gave ethyl butanoate rather than butyl ethanoate. A small proportion of the candidates did not attempt the question.

(c) (i) Candidates needed to give the exact name of the acid with no errors of spelling.

(ii) Many candidates gave partial structural formula rather than the molecular formula $C_4H_8O_2$.

(d) Candidates found this question very challenging and rarely got both the name and formula correct. A common error was sodium carbonate. Since the question only asked for a formula, any type of formula was allowed provided it had the correct molecular formula. A significant proportion of the candidates did not attempt the question.

(e) The identities of the gas **E** and liquid **F** were well known but many candidates gave the name even though the question asked for the formula.

(f) The displayed formula was given full credit, but some candidates included the C_3H_7— group which is ambiguous so was not awarded credit. A significant proportion of the candidates did not attempt the question.

Question 9

This question was about polymers.

(a) (i) Many candidates recognised the ester linkage and only a small proportion of the candidates gave amide.

(ii) Many candidates appreciated that the equation included water, however, this was not sufficient because candidates had to state that the water was a product.

(b) Many candidates were able to calculate the empirical formula. The most common error was to use an incorrect symbol or to use the incorrect atomic mass.

(c) (i) Candidates often gave a suitable explanation referring to the lack of reactivity of polymers, the insoluble nature of the polymers or that the plastic was non-biodegradable

(ii) Candidates often mentioned the production of toxic gases or greenhouse gases but forgot to link the production of these gases to incineration or combustion. Other candidates referred to the need for landfill sites. ‘Land pollution’ on its own was not sufficient.

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

- It is important that candidates have had previous experience with the chemicals and apparatus mentioned in the syllabus before they do the examination.

- With the introduction of flame tests to the syllabus, it is important that candidates have used a Bunsen burner or similar piece of equipment with an air hole so as to obtain a blue/colourless flame for use in a flame test. A spirit burner is not a suitable replacement for a Bunsen burner where flame tests may be required.

General comments

The examination paper includes Notes for use in qualitative analysis. Candidates should have made themselves familiar with these notes and made use of them whilst doing their practical and in answering questions.

Comments on specific questions

Question 1

Candidates did not seem to be very familiar with an endothermic reaction in which the temperature falls by absorbing heat from the surroundings. Candidates often did not recognise that heat is absorbed in the reaction but, after the reaction is complete, the temperature will gradually return to room temperature.

(a) (i) Most candidates were able to observe an initial decrease in temperature which then either became constant or started to increase. Some candidates did not understand how to record the time in seconds and some omitted some of the values required by the instructions. The instructions told candidates to record temperatures to the nearest 0.5 °C. Some candidates did not realise that this meant that all temperatures should be recorded to one decimal place ending in either 0 or 5.

A few candidates obtained an increase in temperature throughout i.e. they thought the reaction was exothermic.

(ii) Many candidates described solutions as clear rather than colourless. All solutions are clear regardless of their colour, so it is possible to have a clear blue solution. Clear is therefore not an acceptable alternative to colourless. Some candidates possibly did not stir the mixture as they incorrectly mentioned undissolved solid or precipitate in the mixture.

(iii) Most candidates were able to calculate the maximum temperature change, however, some calculated the difference between their first and last readings.

(iv) Although many candidates were able to identify trends in their data, some were confused by the fact that there is more than one trend and tried to force the data into one overall trend e.g. temperature increases as time increases. A few candidates answered by stating there was no trend because values go down and up.

(v) Many candidates tried to predict the value by thinking that the upward trend continued for the whole hour. Some predicted values in excess of the boiling point of the mixture. It was clear that many candidates did not understand what was happening in the latter part of the experiment when the solid had fully dissolved and the mixture was returning to room temperature.

(b) Since many candidates did not understand what was happening in the experiment, they were unable to correctly relate the data to energy changes. A common error was to say that the reaction was endothermic at first and then exothermic. This gained no credit.

(c) (i) Most candidates recognised that a burette or pipette is more precise than a measuring cylinder.

(ii) Very few candidates were able to explain what is meant by a more precise measurement. Many candidates made vague statements such as 'use a more precise thermometer' while others referred to the use of a digital measurement of temperature without saying how this made it more precise. The correct answer required candidates to refer to the scale or graduations on the thermometer.

(d) It is important for candidates to read the question carefully as this gives important information in relation to the answer required. Some candidates did not take note of the fact that the calculated value from the data was **less** than the true value. Others ignored the fact that the answer should not have referred to the precision of the measurement. Of those who recognised that the cause was related to lack of insulation, the majority referred to heat loss rather than heat gain from the surroundings.

Question 2

(a) (i) Many candidates gave incomplete answers. Common omissions were lack of reference to limewater as a positive test and failure to conclude that a carbonate could be present in solution **R**. A few candidates incorrectly obtained positive test for other gases. Ammonia was the most common incorrect gas.

(ii) Candidates need to be encouraged to make full use of the 'Notes for use in qualitative analysis' which are provided at the end of the paper. A white precipitate indicating a sulfate ion was the correct observation. Some candidates were confused by the fact that they did not add acid at this stage. However, acid had already been added in **(a)(i)**.

(iii) Some candidates thought that a white, cream or yellow precipitate was formed and made an appropriate conclusion from this observation. Candidates need to be aware that some test results may be negative and that this indicates the absence of certain ions.

(b) (i) Many candidates thought that the colour they observed was orange rather than yellow and concluded that calcium ions were present. It is important that candidates have experience in doing flame tests and can tell the difference between the yellow colour of sodium and the orange-red of calcium.

(ii) Very few candidates were able to answer this correctly. Some centres reported that they used a spirit burner rather than a Bunsen burner. These are not appropriate for flame tests. Many candidates were aware of the function of the air hole and referred to more oxygen getting to the flame and higher temperatures but very few were able to link it to the colour of the flame. It is important that a blue or colourless flame is used so that the colour from the flame test can be observed.

(c) Candidates were given credit in this part for errors carried forward from their observations. They needed to combine an identified cation with an identified anion to give an appropriate formula. Credit is not given if candidates choose to use a formula rather than a name but then make an error in the formula.

(d) Candidates found this difficult. Many just repeated the test for a chloride and a bromide. Others thought that a displacement reaction would take place if **R** was added to potassium bromide and an orange solution would be formed.

(e) This was not well answered. Credit was given for any method that would work but the types of answers given showed that candidates were not familiar with how to do a test for carbon dioxide whilst doing a carbonate test. This could account for why some candidates did not get a positive result in **(a)(i)**.

Question 3

Candidates are improving in their ability to answer planning questions. It is important that candidates make use of the information provided in the question. Candidates should avoid any plan that makes use of chemicals that are not mentioned in the question when it clearly states, 'No other chemicals should be used'. The question also states what their plan **must** include. Failure to address any of these points will mean that full credit cannot be obtained.

Writing an apparatus list alone is not sufficient for the apparatus marks. Candidates need to make it clear how the apparatus is used.

Most candidates were able to gain some credit for their method, although some candidates wrote a plan to produce copper sulfate crystals whilst others described a titration or a distillation.

Few candidates were able to suggest techniques to ensure accuracy, or appreciate that it was important for the acid to be in excess to ensure that all of the carbonate had reacted, or describe how they knew that the reaction was complete when they recorded a volume. They also did not recognise that gas loss could cause inaccuracy and consequently did not describe methods to prevent or reduce gas loss in the experiment. A number of candidates recognised that repeating the experiment was good practice but few linked this to taking an average or identifying anomalous value.

CHEMISTRY

Paper 5070/41
Alternative to Practical

Key messages

- In **Question 1**, it was important that candidates were careful in their reading and following of the instructions. Candidates were sometimes made errors in reading the information in the question stem.
- In **Question 2**, candidates should use the same degree of precision as already shown in the question.
- In **Question 3**, candidates should be encouraged to use the 'Notes for use in qualitative analysis' to help them obtain correct answers.
- In **Question 4**, candidates should have clearly explained procedures to ensure accuracy. This was specified in the question, so a full answer had to address that point.

General comments

In **Question 1**, the majority of candidates were successful, although those who rushed through the question may have missed key information. In **Question 2**, most candidates were able to answer questions about the exothermic reactions described. Improvements could be made in the 'explanation' questions by using information in the question stem to inform answers. In **Question 3**, candidates should be aware that in addition to the use of the 'Notes for use in qualitative analysis' they may also be required to use their knowledge of procedures, such as for the flame tests in **Question 3(a)**.

In **Question 4**, most candidates addressed the first two bullet points. Successful responses explained how to calculate the percentage loss in mass and how to ensure that the percentage value obtained was as accurate as possible.

Candidates should be encouraged to read questions carefully. A number of candidates gave answers that were not successful because of not carefully considering the information given in the question, so omitting to answer at least some part of the question.

Comments on specific questions

Question 1

(a) (i) The majority of candidates successfully named the apparatus as a measuring cylinder.

(ii) Most candidates recognised that a more suitable piece of apparatus to use would be a volumetric pipette.

(iii) This question was also answered successfully, naming the apparatus as a burette.

(iv) This question required candidates to read the correct value from the burette. Many candidates then gave that value as their answer (23.6 cm^3). Better performing candidates carefully read the question which stated, 'The initial reading on this apparatus is 1.0 cm^3'. They therefore subtracted 1.0 cm^3 from 23.6 cm^3 to give the correct answer of 22.6 cm^3. Candidates should be encouraged to check their answers to avoid simple errors.

(b) Candidates were asked to state what the apparatus shown in Fig. 1.2 should be washed with. As in **(a)(iv)**, those who rushed the question simply said, 'distilled water' and did not achieve credit. Those that took time to carefully read the question realised that above Fig. 1.2, the description stated, 'Fig. 1.2 shows the apparatus used to determine the volume of HA(aq) at the end of the experiment.' These candidates realised that as the burette was being used to measure the volume of HA, it should also be washed with HA.

(c) This question asked for the colour change of methyl orange at the end-point. Most candidates successfully stated that the colour change would be yellow to pink/red.

Question 2

(a) (i) Candidates were asked to identify the value from the table that had been recorded to an incorrect degree of precision. Most candidates noted that it was 20. All other results were written to 1 decimal place, but this one was not.

(ii) Most candidates were successful on this question, where they were asked to complete the table using the temperatures for **D** that were shown on the thermometers in Fig. 2.1. A significant minority misunderstood the scale on the thermometers and rather than reading the values as 21.0 °C and 53.5 °C, they read them as 20.1 °C and 50.35 °C. Slowing down and reading the data provided twice may have helped. There was also credit on this question for writing all of the values to 1 decimal place, continuing the degree of precision that was already shown in the table.

(iii) Most candidates successfully noted that **B** is in excess because there is some **B**, or some grey solid, remaining at the end of the reaction.

(iv) In this question candidates were asked to give the formulae for the colourless solution, the grey solid and the brown solid. Most candidates correctly identified the three chemicals as BSO_4, **B** and Cu. There were some candidates who attempted to give the actual formula of a metal, rather than using the term '**B**', but as the question stated, 'Using the equation in **(iii)**', they should have realised they had to use the formulae from the equation, which used the term, '**B**'.

(b) The majority of candidates were able to arrange the metals in descending order of temperature change correctly, **A**, **C**, **D**, **B**. The question then asked candidates to 'Explain how the results give this order of reactivity.' To answer correctly, candidates should have stated that the greater the temperature change, the more reactive the metal. Only a minority of candidates realised that, as the results showed temperature increases, they needed to be relating their explanation to temperature increase also. Most candidates were referring to completely unrelated factors in their explanation.

(c) In this question the candidates were asked to suggest a temperature increase that would be obtained if the experiment was repeated with a fifth metal, where the fifth metal would be the second most reactive. Candidates should have given a temperature increase value that would be between their two highest temperature increases. Most candidates successfully gave a value higher than 39.0 °C and less than 49.5 °C.

(d) The candidates should have carefully read the question stem, which stated that the temperature increases which are calculated are less than the true values. The question asked candidates to give a reason to explain this and an improvement. Some candidates referred to errors which may have caused different values, such as errors in stirring, or measuring readings. Those type of random errors would cause the calculated values to be different than the true values, but not necessarily less than the true values. Better performing candidates realised this and correctly gave the reason as heat loss to the surroundings and an improvement involving some form of insulation to reduce the loss.

(e) Most candidates successfully recognised that if the concentration of aqueous copper(II) sulfate is reduced then the temperature increase will also be reduced. A smaller proportion of candidates also stated that the temperature increase would be reduced by approximately half. The further explanation that this is because there are only half the number of copper ions to react was rarely stated.

Question 3

(a) (i) In this question candidates are told that a wooden splint, which is damp with **R**, is held in a blue Bunsen Burner flame and turns red then yellow. Having learned about how to successfully carry out flame tests, candidates should be aware that it is only the initial colour that is noted. In this example, only the red colour is of note and is due to **R**. The yellow colour appears after the red and would be due to the splint itself burning. Candidates were asked for two possible conclusions from the flame test. Most candidates incorrectly gave the conclusion of sodium ions being present as one of their options, due to the presence of the yellow colour. The correct answer is that the possible conclusions are lithium ions or calcium ions.

(ii) Most candidates incorrectly stated that the difficulty in making a definite conclusion from the flame test observation is because two colours were shown as only the initial red colour is relevant. Therefore, the reason that it is difficult to make a definite conclusion is because two metal ions would both show a red colour.

(b) In this question candidates were told that **R** was tested with nitric acid and barium nitrate. They were also told that **R** does not contain sulfate ions. Candidates had to use the 'Notes for use in qualitative analysis' to identify the observation which would show this. The majority of candidates were successful in identifying the observation of there being no change/a colourless solution.

(c) As with **(b)**, credit for this question could have been attained by using the 'Notes for use in qualitative analysis'. Most candidates successfully gave the answer of chloride ions being present.

(d) (i) Candidates were told that silver nitrate is added to aqueous sodium carbonate, giving a white precipitate. Nitric acid is then added and the white precipitate dissolves, leaving a colourless solution. There were asked to describe one other observation. The keyword here is 'observation' and candidates needed to describe what they would see. Stating, 'a gas is formed', or 'carbon dioxide is formed' is not an observation. Better performing candidates described how they would see 'effervescence', 'fizzing' or 'bubbles'.

(ii) Candidates needed to explain why it is important to add nitric acid to the silver nitrate test that was carried out in **(c)**. The most common answer to this question was 'to acidify it'. This answer describes what the acid does, but does not suggest why this is important. Better performing candidates realised that adding nitric acid is important as it prevents ions other than chloride ions forming a white precipitate.

(e) This question required successful use of the 'Notes for use in qualitative analysis'.

(f) This could also be answered by using the 'Notes for use in qualitative analysis'. Candidates were asked to describe what should be done in order to confirm that calcium ions are present. They could either have stated that excess sodium hydroxide should be added and the white precipitate would remain, or that aqueous ammonia could be added and no white precipitate would be given. Most candidates were successful with this question, approximately half giving each of the two options.

(g) (i) Most candidates successfully stated that to confirm the production of ammonia gas, the observation would be that damp red litmus paper turns blue.

(ii) Candidates were asked to identify a cation, other than calcium, present in **R**. Candidates should have recognised that as this was still part of **(g)** where they had just been asked how to test for ammonia gas, the cation that should have been given was ammonium, NH_4^+.

(h) Candidates were asked to suggest the names of the two ionic compounds present in **R**. A number of candidates successfully stated the two compounds were calcium chloride and ammonium chloride. There were a number of candidates who either just gave the names of the ions alone (the question specifically asks for the names of the compounds), or who wrote incorrect formulae in addition to the names. As the question asked for 'names', candidates are advised not to include formulae at all, because if the formulae are incorrect then credit is cannot be awarded for the names.

Question 4

Candidates were asked to plan an experiment to determine the percentage loss in mass when barium carbonate is heated. There were then four bullet points indicating to the candidates what they should include in their plan. Better performing candidates noted these bullet points and addressed these in their answer. Credit was awarded from a labelled diagram, especially for the 'apparatus needed' bullet point.

The majority of candidates successfully described the use of suitable apparatus, so fulfilling the first bullet point. Most candidates were also able to describe the process of obtaining the start mass of barium carbonate, heating the sample, then obtaining the end mass of barium oxide, so giving suitable points for the second bullet point.

Although fewer candidates successfully addressed the third bullet point, by giving procedures to ensure that the percentage determined is as accurate as possible, a number did gain credit by stating that the procedure should be repeated and an average calculated. Candidates could also have described reheating and reweighing the sample until a constant mass is obtained.

The best responses also addressed the last bullet point, by correctly giving the calculation needed in order to determine percentage loss in mass.

Although most candidates were successful in this question, there were some candidates who described a different practical altogether, such as a titration, or the preparation of a salt. Candidates should be encouraged to spend time carefully reading the question stem to ensure they are giving an answer to the actual question that has been asked.

CHEMISTRY

Paper 5070/42
Alternative to Practical

Key messages

It is important that candidates have had experience of practical activities in order for them to fully understand and respond to experiments described in the alternative to practical questions.

General comments

The examination paper includes 'Notes for use in qualitative analysis'. Candidates should have made themselves familiar with these notes and made use of them whilst answering questions.

Comments on specific questions

Question 1

(a) (i) Most candidates correctly identified the measuring cylinder. Some thought it was a burette.

(ii) Many candidates thought that volumetric pipettes can only measure 25 cm^3 of solution. Others were confused over whether a measuring cylinder or a pipette was more precise. Only a few identified the fact that the method asks for an approximate volume and so the level of precision from a pipette is unnecessary.

(iii) Not many candidates referred to the use of a safety pipette filler when describing how to use a volumetric pipette.

(b) Most candidates knew that a burette is used. A few thought that a pipette was suitable. The most common incorrect answer was to call it a dropper.

(c) Some candidates thought this was something to do with the presence of acid in the mixture and wrote about pH or acid base reactions. Many were aware that the potassium manganate(VII) was self-indicating and changed colour at the end point. It was insufficient to only state that the reactants were coloured.

(d) Very few candidates were able to answer this correctly. Phrases such as 'results are close together', 'results are the same' and 'when an average can be calculated' were common answers. Candidates need to be aware of a suitable tolerance in their results. At this level, a variation of 0.2 cm^3 or less is acceptable. The use of the word concordant was also taken as describing this level of agreement.

Question 2

(a) (i) Most candidates were able to take the reading from the diagram. Some read the scale from the top instead of the bottom of the scale i.e. recorded values of 26.5 and 25. A significant number of candidates did not understand what was meant by recording the value to the nearest 0.5 °C. Many wrote the temperature at 300 s as 15 rather than 15.0.

(ii) Many candidates calculated this correctly. Some incorrectly subtracted the first and last value instead.

(iii) The idea that a set of data can have more than one trend seemed to be unknown by some candidates. The question specifically mentions 'trends' rather than 'a trend' to try to guide

candidates to this. Some candidates tried to force the data into one overall trend e.g. temperature increases as time increases. A few candidates answered by stating there was no trend because values go down and up.

(iv) Many candidates tried to predict the value by thinking that the upward trend continued for the whole hour. Some predicted values in excess of the boiling point of the mixture. It was clear that many candidates did not understand what was happening in the latter part of the experiment when the solid had fully dissolved and the mixture was returning to room temperature.

(b) Since many candidates did not understand what was happening in the experiment, they were unable to correctly relate the data to energy changes. A common error was to say that the reaction was endothermic at first and then exothermic. This gained no credit.

(c) This was often well answered. Some candidates only referred to mixing rather than to temperature or dissolving.

(d) Very few candidates were able to explain what is meant by a more precise measurement. Many candidates made vague statements such as 'use a more precise thermometer' while others referred to the use of a digital measurement of temperature without saying how this made it more precise. The correct answer required candidates to refer to the scale or graduations on the thermometer.

(e) It is important for candidates to read the question carefully as this gives important information in relation to the answer required. Some candidates did not take note of the fact that the calculated value from the data was **less** than the true value. Others ignored the fact that the answer should not have referred to the precision of the measurement. Of those who recognised that the cause was related to lack of insulation, the majority referred to heat loss rather than heat gain from the surroundings.

Question 3

(a) (i) Most candidates knew that sodium gives a yellow flame colour. Some candidates thought that a yellow solution was formed.

(ii) Very few candidates were able to answer this correctly. Many candidates were aware of the function of the air hole and referred to more oxygen getting to the flame and higher temperatures but very few were able to link it to the colour of the flame. It is important that a blue or colourless flame is used so that the colour from the flame test can be observed. Answers such as 'to make the colour visible' were insufficient.

(b) (i) The questions asks for 'conclusions' not 'a conclusion'. This should give candidates the idea that more than one statement was required. Some candidates only referred to the formation of carbon dioxide and did not link this to a carbonate being present.

(ii) Most candidates realised that this was a test for a sulfate.

(iii) Candidates find it more difficult to make conclusions from negative observations. A significant number of candidates thought this showed that chloride was present. Some others misunderstood the question and said that a white precipitate is formed. It is also important that candidates realise that the test is for chloride, bromide or iodide and so a negative result shows that none of these are present, not just that chloride is not present.

(iv) This was often well answered. Some candidates only mentioned litmus and did not mention the fact that it needs to be red. Some candidates described the test as if ammonium ions were present rather than not present. Some candidates tried to describe a nitrate test.

(c) Candidates found it difficult to put the results and conclusions from previous parts together to deduce the possible compounds that are present. The question asks candidates to name the compounds not to write the formulae. Correct formulae were credited but an error in a formula meant that a candidate did not gain credit.

(d) Candidates found this difficult. Many just repeated the test for a chloride and a bromide. Others thought that a displacement reaction would take place if **R** was added to potassium bromide and an

orange solution would be formed. Differentiating between white and cream in a halide test is difficult and so comparing the colours with known samples of silver chloride and silver bromide is a good practical technique which could be used in a school laboratory. It appeared from the answers given that some candidates had not seen this test in practice and therefore, did not appreciate the difficulty in distinguishing between white and cream precipitates.

(e) This was not well answered. Credit was given for any method that would work but the types of answers given showed that candidates were not familiar with how to test for carbon dioxide whilst doing a carbonate test.

Question 4

Candidates are improving in their ability to answer planning questions. It is important that candidates make use of the information provided in the question. Candidates should avoid any plan that makes use of chemicals that are not mentioned in the question when it clearly states, 'No other chemicals should be used'. The question also states what their plan **must** include. Failure to address any of these points will mean that full credit cannot be obtained.

Writing an apparatus list alone is not sufficient for the apparatus marks. Candidates need to make it clear how the apparatus is used.

Most candidates were able to gain some credit for their method, although some candidates wrote a plan to produce copper sulfate crystals whilst others described a titration or a distillation.

Few candidates were able to suggest techniques to ensure accuracy, or appreciate that it was important for the acid to be in excess to ensure that all of the carbonate had reacted, or describe how they knew that the reaction was complete when they recorded a volume. They also did not recognise that gas loss could cause inaccuracy and consequently did not describe methods to prevent or reduce gas loss in the experiment. A number of candidates recognised that repeating the experiment was good practice but few linked this to taking an average or identifying anomalous value.