

Principal examiner reports for teachers

Principal examiner reports for teachers summarise what candidates did well and what candidates needed to improve for this examination series only.

This report is to be used in conjunction with the question paper and mark scheme.

For guidance on teaching and learning we provide resources for many of our syllabuses.

Resource	Where to find it
Grade descriptions – Grade descriptions describe the level of performance typically demonstrated by candidates achieving the different grades awarded for a qualification.	School support hub Select: Subject > Resource finder > Syllabus and specimen materials
Schemes of work – Schemes of work are designed to support you in your teaching and lesson planning.	School support hub Select: Subject > Resource finder > Teaching and learning
Lesson planning – Guidance on how to plan a lesson.	Lesson planning
Resource plus – There may be additional resources such as teaching packs containing lesson plans, resources and worksheets and videos for aspects of your syllabus.	School support hub Select: Subject > Resource finder > Teaching and learning
Teaching tools	Teaching Tools
Exemplar candidate responses	School support hub Select: Subject > Resource finder > Teaching and learning
Learner guide – A guide for students to help them understand what the course involves.	School support hub Select: Subject > Resource finder > Teaching and learning
Community forums – Do you have a question or something to share? Our online forums are great way to keep up to date with your subject and the global Cambridge community.	Community forum on the school support hub
Access to scripts for this series.	Access to scripts service
Results analysis is available for some syllabuses.	Results analysis
Test maker is available for some subjects.	Test maker

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CHEMISTRY

Paper 5070/11 Multiple choice
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Key messages

Candidates performed well on **Questions 1, 2, 3, 6, 7, 8, 11, 12, 14, 17, 18, 19, 22, 24, 25, 26, 29, 30, 34, 35, 38 and 39.**

Candidates performed less well on **Questions 4, 5, 9, 10, 13, 15, 16, 20, 21, 23, 27, 28, 31, 32, 33, 36, 37 and 40.**

Candidates should take care to read the full question before answering. Some options may give answers that are either correct statements which do not answer the question or are statements that are only partially correct.

Comments on specific questions

Question 4

- Options **B** and **D** were common incorrect answers.
- Candidates needed to understand that a hydrogen ion consists of just a proton.

Question 5

- Options **C** and **D** were common incorrect answers.
- Some candidates decided to choose between the two dot-and-cross diagrams which have errors in both.

Question 9

- Option **C** was a common incorrect answer.
- Candidates choosing option **C** did not consider the concentration of the solution being made.

Question 10

- Option **B** was a common incorrect answer.
- Candidates needed to understand that the lost mass is due to carbon dioxide being released and that the number of moles of copper carbonate in the sample is the same as the number of moles of carbon dioxide released.

Question 13

- Options **A** and **D** were common incorrect answers.
- The incorrect answers suggest that some candidates did not understand that hydrogen and oxygen are consumed in a hydrogen-oxygen fuel cell.

Question 15

- Option **A** was a common incorrect answer.
- Candidates needed to understand which reagent was in excess and use that to predict the final volumes of hydrogen produced in the three experiments.

Question 16

- Option **C** was a very common incorrect answer.
- Candidates needed to appreciate that adding aqueous sodium hydroxide would reduce the concentration of hydrochloric acid and therefore shift the equilibrium to the right.

Question 20

- Option **D** was a common incorrect answer.
- Candidates needed to recall the trends in density and melting point going down Group I of the Periodic Table.

Question 21

- Option **C** was a common incorrect answer.
- Candidates needed to recognise that the colour change of bromine in this displacement reaction is not the same as the colour change when bromine is used to test for unsaturated organic compounds.

Question 23

- Option **B** was a common incorrect answer.
- Some candidates did not appreciate the fact that helium does not have an outer shell containing 8 electrons.

Question 27

- Option **B** was a common incorrect answer.
- Candidates needed to recall that in the extraction of aluminium, the carbon anode gradually wears down as it reacts with oxygen.

Question 28

- Option **C** was a common incorrect answer.
- Most candidates recalled the colour changes in the tests for water and fewer candidates recognised that the sample is impure and so the boiling point would be affected.

Question 31

- Option **B** was a common incorrect answer.
- Some candidates did not recognise the fact that structure 2 is an ester rather than a carboxylic acid.

Question 32

- Option **B** was a common incorrect answer.
- The compound is not saturated because it is not possible to add two hydrogen atoms to a saturated compound.

Question 33

- All options were equally popular.
- Candidates needed to understand that there are two structural isomers of the product given. Although the reaction is a photochemical reaction, the term 'photosynthesis' is reserved for a different process.

Question 36

- Options **A** and **B** were common incorrect answers.
- One of the key differences between condensation and addition polymerisation is that in the former process, an additional product is formed.

Question 37

- All three incorrect options were equally popular.
- Candidates needed to recall the definition of a solute and appreciate the meaning of 'saturated' when applied to solutions as opposed to its meaning when applied to organic compounds.

Question 40

- Option **C** was a common incorrect answer.
- The question depends on an understanding of the difference between the ammonium ion test and the nitrate ion test.

CHEMISTRY

Paper 5070/12 Multiple choice
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Key messages

Candidates performed well on **Questions 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 16, 17, 18, 21, 23, 24, 25, 26, 28, 29, 32, 33, 35, 36 and 39.**

Candidates performed less well on **Questions 1, 2, 7, 8, 15, 19, 20, 22, 27, 30, 31, 34, 37, 38 and 40.**

Candidates should take care to read the full question before answering. Some options may give answers that are either correct statements which do not answer the question or are statements that are only partially correct.

Comments on specific questions

Question 1

- Option **A** was a common incorrect answer.
- Although ammonia has the lowest molecular mass, it would be a liquid at the temperature used in the question.

Question 2

- Option **A** was a common incorrect answer.
- Although option **A** is partially correct, air contains elements as well as compounds.

Question 7

- Option **C** was a common incorrect answer.
- Some candidates overlooked the fact that there are three atoms of Z in the compound for each atom of either X or Y.

Question 8

- Options **B** and **C** were common incorrect answers.
- Candidates needed to understand that the oxygen would be in excess and so, using the stoichiometry in the equation, only 1 dm³ of product is possible.

Question 15

- All options were quite popular.
- The question depends on the fact that X is in excess so even if most of the Y reacts there must be more than 0.5 mol of X remaining in the equilibrium mixture. Likewise, because the system is an equilibrium mixture, the amount of XY₂ produced must be less than 1.0 mol. Candidates also needed to appreciate that the reaction does not stop when equilibrium is reached.

Question 19

- Option **C** was a common incorrect answer.
- Candidates needed to recall the fact that both acidic and amphoteric oxides react with alkalis.

Question 20

- The three incorrect options were equally popular.
- The question depends on understanding that the atomic number of an element equates to the number of protons, and therefore the charge, in the nucleus of each atom.

Question 22

- The three incorrect options were equally popular.
- Candidates needed to recall the properties of the elements in Groups I and VII of the Periodic Table.

Question 27

- The three incorrect options were equally popular.
- Candidates needed to select an element that is more reactive than copper and also does not produce hydrogen when added to water.

Question 30

- Option **A** was a common incorrect answer.
- Although carbon monoxide is removed in a catalytic converter, it is oxidised rather than reduced in the process.

Question 31

- Option **B** was a common incorrect answer.
- Some candidates realised that the effects of a ring and a double bond on the ratio between carbon and hydrogen atoms in a hydrocarbon are the same. Candidates could also have counted the number of atoms of each element.

Question 34

- Option **C** was a common incorrect answer.
- Candidates who wrote balanced equations for the two reactions would have been recognised that an extra 1.5 mol of oxygen is required for each 1.0 mol of alcohol.

Question 37

- Option **C** was a common incorrect answer.
- Candidates needed to recall that a balance is required for a change in mass experiment and that a crucible should be used for heating the magnesium.

Question 38

- Option **D** was a common correct answer.
- Since option **D** is just the first three acids in the table, it is likely that not all candidates were familiar with how to calculate R_f values.

Question 40

- Option **A** was a common incorrect answer.
- Besides requiring a familiarity with the cation tests, this question also depends on an understanding of the difference between the ammonium ion test and the nitrate ion test.

CHEMISTRY

Paper 5070/21 Theory

Key messages

What candidates did well

- Underlined or highlighted key words or phrases in questions so that they could focus on what was being asked.
- Dot-and-cross diagram of a nitrogen molecule.
- Products of electrolysis.
- Understanding why reagents are in excess in reactions.

What candidates needed to improve

- Candidates need to read questions carefully so that they answer what is being asked, for example, 2(a) where the question asked for the answer to **three** significant figures.
- Use of technical terms, for example, atom, ion, intermolecular forces, molecular formula.
- Construction of equations.

Comments on specific questions

Question 1

(a) Comprehensive responses

- The amphoteric oxide was well known.

Limited responses

- Common incorrect responses included $AlCl_3$, Na_2O , CO_2 and SO_2 .

(b) Comprehensive responses

- Many candidates chose the correct molecule.

Limited responses

- Common incorrect responses included NH_2OH , $AlCl_3$ and Na_2O .

(c) Comprehensive responses

- Some candidates counted the electrons in the molecule correctly.

Limited responses

- Common incorrect responses included NO , KBr and $AlCl_3$.

(d) Comprehensive responses

- Some candidates applied the principle of oxidation number correctly.

Limited responses

- Common incorrect responses included Na_2O , CO_2 and NO_2 .

(e) Comprehensive responses

- Unsaturated was a well-known term.

Limited responses

- Common incorrect responses included NH_2OH and also mixing the terms saturated and unsaturated and so choosing CH_4 .

Question 2

(a) Comprehensive responses

- Many candidates calculated the volume of nitrogen correctly, often showing the steps in their calculation clearly.

Limited responses

- A significantly large number of candidates did not give their final answer to the required three significant figures. Other incorrect responses included: calculating the M_r of NaN_3 as 88, 63 and 64; calculating in mass rather than moles; inverting the stoichiometry and so multiplying by $2/3$ and dividing by 24 instead of multiplying.

(b)(i) Comprehensive responses

- Very few candidates explained both parts of the term correctly.

Limited responses

- Those candidates who knew that an ionic structure was comprised of alternating positive and negative ions usually did not appreciate that lattice meant that the structure was regular. Many candidates discussed covalent bonds, molecules, atoms and intermolecular forces between ions.

(ii) Comprehensive responses

- Most candidates gave at least one correct property, with many giving two.

Limited responses

- Some candidates gave soluble without identifying the solvent as water or conducts electricity without specifying the state in which it could conduct. Other incorrect responses included density, hardness, ductility or the properties of metals including shiny, malleable and ductile.

(iii) Comprehensive responses

- Some candidates deduced the formula correctly.

Limited responses

- The most common incorrect response was N_3^{2-} , others included N^{3-} , N_3^+ and N_3^{3-} . A small number of candidates omitted the question.

(c) Comprehensive responses

- The structure of a gas was well known.

Limited responses

- Some candidates addressed only two of the three aspects requested. Other responses were often vague such as not touching or spaced instead of far apart, not fixed instead of random or irregular and moving or moving freely for moving fast or randomly.

(d) Comprehensive responses

- Many candidates drew a correct dot-and-cross diagram for the bonding electrons and also the non-bonding electrons.

Limited responses

- Many candidates drew either a single bond or a double bond between the two nitrogen atoms. Some drew a single nitrogen atom with 5 electrons, and a small number thought the atoms were ionically bonded.

(e) Comprehensive responses

- Some candidates appreciated the weak intermolecular forces were responsible for the low boiling point.

Limited responses

- Those candidates who discussed intermolecular forces frequently gave them as between atoms, ions or bonds. Another common incorrect response gave covalent bonds as the reason.

Question 3

(a) (i) Comprehensive responses

- Many candidates used the Figure correctly to answer the question.

Limited responses

- Some candidates did not use the Figure and answered from their own knowledge, for example, energy is given out and ΔH is negative. Some compared the activation energy as being less than ΔH .

(ii) Comprehensive responses

- Bond breaking and bond making in an exothermic reaction was quite well known.

Limited responses

- Many candidates reversed the exothermic and endothermic processes. The most common error was to describe both processes as needing energy.

(b) Comprehensive responses

- Some candidates gave a good definition.

Limited responses

- The most common error was to omit the word minimum from their definition.

(c) Comprehensive responses

- Advantages and disadvantages of the hydrogen-oxygen fuel cell were not well known.

Limited responses

- Whilst many candidates appreciated that water was made, few said it was the only product. Answers tended to be too vague. For example, for advantages: not toxic, non-polluting, better for the environment, no greenhouse gases and no climate change; and for disadvantages: high cost and less effective.

(d) Comprehensive responses

- Some candidates gave detailed answers which were comparative.

Limited responses

- Many candidates thought that as the pressure decreased so the energy or speed of the particles decreased. Some gave non-comparative answers such as particles are close. A small number discussed equilibrium, and a significant number did not answer in terms of particles. Those that considered collisions frequently discussed just collisions or successful collisions rather than frequency.

(e) Comprehensive responses

- Many candidates gave detailed answers which were comparative.

Limited responses

- Particles were not mentioned in some responses and many discussed frequency of collisions rather than their success. Successive was also used in place of successful.

Question 4

(a) Comprehensive responses

- Many candidates gave the correct electrolysis products at the electrodes.

Limited responses

- For concentrated aqueous potassium hydroxide, common incorrect responses included at the anode: iodide, potassium, oxygen, potassium hydroxide and OH^- , and at the cathode: iodine, iodide, potassium, hydrogen and potassium hydroxide.

For dilute aqueous potassium iodide, at the anode: iodine, potassium, potassium hydroxide and OH^- , and at the cathode: iodine, potassium hydroxide and potassium.

(b) Comprehensive responses

- Some candidates gave at least one correct ionic half-equation, usually for potassium.

Limited responses

- Common incorrect equations for the anode included: $I^- \rightarrow I + e^-$, $2I^- + 2e^- \rightarrow I_2$ and $I_2 \rightarrow 2I^- + 2e^-$. For the cathode $K \rightarrow K^+ + e^-$ and $2K^+ + 2e^- \rightarrow K_2$

(c) Comprehensive responses

- Most candidates gave at least one correct reason, and many gave two.

Limited responses

- Incorrect responses included conducts heat, high boiling point, durable and strong.

(d)(i) Comprehensive responses

- Some candidates gave the correct oxidation number.

Limited responses

- The most common incorrect response was the charge 2+. Others included 1+, +1, 0, 2 and 1.

(ii) Comprehensive responses

- Oxidation of the iodide ion was well known.

Limited responses

- Most candidates thought that copper was reduced and did not appreciate that it is the copper(II) ion that is reduced. Iodine losing an electron was also quite common. A small, significant number reversed the gain and loss of electrons.

Question 5

(a) Comprehensive responses

- Many candidates gave an observation.

Limited responses

- A common response was that it gives off a gas which is not an observation. Changes colour was also seen quite often.

(b) Comprehensive responses

- The need to use all of the acid was quite well known.

Limited responses

- Common incorrect responses included to use all of the aluminium for a complete reaction and to get the maximum amount of product.

(c) Comprehensive responses

- Many candidates gave a clear and detailed calculation.

Limited responses

- Some calculated the number of moles of aluminium as 0.83 rather than 0.083. Many rounded intermediate values to one decimal place rather than retaining at least two decimal places. Intermediate values should ideally be retained in full throughout the calculation and rounded only at the final step. Some inverted the stoichiometry and multiplied by 2/3 or just 2. Some did not take the stoichiometry into account. A small number omitted the question.

(d) Comprehensive responses

- Filtration was very well known.

Limited responses

- Incorrect responses included evaporation and distillation.

(e) Comprehensive responses

- Few candidates gave a full and logical account of crystal preparation.

Limited responses

- Many candidates evaporated the solution to dryness thus producing a powder. Those that evaporated some of the water often did not leave the solution to cool down. Few washed the crystals or gave a method of drying. A significantly number omitted the question.

(f) Comprehensive responses

- Some candidates calculated the percentage correctly.

Limited responses

- The mass of the 16 waters was frequently incorrect, often given as 32 or 48. M_r of the hydrated salt or the anhydrous salt was frequently 360. Common ratios were $288 \div 352$, $18 \div 360$, $342 \div 630$ and $48 \div 342$. A significant number omitted the question.

(g) Comprehensive responses

- Some candidates knew the test for aluminium ions.

Limited responses

- Common responses for a few drops of sodium hydroxide included precipitate (no colour given), colour change and it is neutralised. Excess sodium hydroxide was frequently omitted, and many thought the precipitate was insoluble. A small number omitted the question.

Question 6

(a) Comprehensive responses

- Many candidates gave two chemical properties.

Limited responses

- The most common error was to give on or two physical properties, often malleable, high melting point and high density.

(b) Comprehensive responses

- Some candidates explained that it is the mobile electrons which make iron a good conductor.

Limited responses

- Many thought that the electrons being present, delocalised or free was sufficient to explain conductivity. Some thought that the ions were mobile.

(c) (i) Comprehensive responses

- Some candidates could name one or two elements.

Limited responses

- The most common incorrect element was zinc. Copper, aluminium and silver were also common.

(ii) Comprehensive responses

- Few candidates had both the different sized atoms/ions and the effect this has on the ability of the layers to slide.

Limited responses

- Many thought the bonding between the elements was strong thus making the alloy strong. Some described the bonding in metals or thought that the alloy was made of molecules. Most did not consider layers at all.

(iii) Comprehensive responses

- A wide range of responses was seen for this longer question. Many candidates demonstrated some understanding of the process, most commonly by identifying that carbon burns to produce carbon dioxide..

Limited responses

- Few candidates mentioned oxygen was needed to form the carbon dioxide. Many thought that carbon dioxide reacted with oxygen to form carbon monoxide and that haematite contained iron(II) oxide. The formula for calcium oxide was frequently Ca_2O and calcium silicate CaSiO_2 or CaSiO_4 . It is worth noting here that the answer could have been totally in words, totally in equations or a mixture of both. When both are used, the words and the equations should not contradict each other. A small number omitted the question.

Question 7

(a) Comprehensive responses

- A small number of candidates defined condensation correctly.

Limited responses

- The most common incorrect response was gas turning into liquid. Some went part way by saying that water was formed without considering polymerisation or described the monomers forming a polymer without considering condensation. A significant number omitted the question.

(b)(i) Comprehensive responses

- Amino acid was quite well known.

Limited responses

- Common incorrect responses included amide, carboxylic acid, polyamide and ethene.

(ii) Comprehensive responses

- Few candidates knew the general structure of an amino acid.

Limited responses

- Many gave either the repeat unit of a protein or a section of nylon. There were many unidentifiable polymer sections often with 3– or 5– valent carbon atoms or two separate monomers of a carboxylic acid or dicarboxylic acid and a diamine. A significant number omitted the question.

(iii) Comprehensive responses

- Many candidates circled the linkage correctly.

Limited responses

- Some circled only part of the link or just the N or the O and some circled the carbon chain in addition to the link. A significant number omitted the question.

(c)(i) Comprehensive responses

- Some candidates named the monomers.

Limited responses

- Many candidates thought the monomers were diamine and dialcohol. Other incorrect responses included amide, carboxyl, carbon, ethene and terylene. A significant number omitted the question.

(ii) Comprehensive responses

- The environmental challenge of plastic disposal was quite well known.

Limited responses

- Many answers were vague and insufficient including pollution, litter, waste, land pollution and harmful gases when burned.

Question 8

(a) Comprehensive responses

- Some candidates described the manufacture of ethanol from ethene.

Limited responses

- Some described fermentation from glucose or hydrogenation. The temperatures and pressures quoted were frequently out of range and the most common catalyst was nickel. For the equation, common incorrect reactants included C_2H_6 , C_2H_2 and CH_4 and incorrect products included C_2H_4OH , C_2H_6OH and C_2H_5O . Many omitted including an equation. A significant number omitted the question.

(b) Comprehensive responses

- Some candidates gave a fully correct displayed formula.

Limited responses

- For those candidates who drew the correct compound, many did not display the O-H bond. Other incorrect responses included butan-1-ol, butanal, methyl propan-1-ol and $C=OH$.

(c) (i) Comprehensive responses

- The name and spelling of the ester was well-known.

Limited responses

- The two most common incorrect responses were ethyl propanoate and propyl ethanoate.

(ii) Comprehensive responses

- Some candidates drew the structure correctly.

Limited responses

- Incorrect responses included $C_2H_5COC_2H_5$, $C_2H_5CH=OHC_2H_5$ and $C_2H_5COC_2H_4OH$. A significant number omitted the question.

(iii) Comprehensive responses

- Some candidates gave a correct condition usually acid catalyst or concentrated sulfuric acid.

Limited responses

- Incorrect responses included high temperature, $u - v$, high pressure and catalyst. A significant number omitted the question.

(d) Comprehensive responses

- More candidates gave the structural formula than gave the molecular formula.

Limited responses

- Incorrect responses usually involved miscounting $C_8H_{17}O$, $C_8H_{15}OH$, $C_8H_{16}OH$ or some gave the full structural formula. A significant number omitted the question.

CHEMISTRY

Paper 5070/22
Theory

Key messages

What candidates did well

- Candidates were able to understand how to use bond enthalpy values to calculate an enthalpy change.
- Many candidates showed the working out for calculations involving stoichiometry.
- Candidates were able to give good explanations about the factors that affect the rate of a reaction using the correct terminology to describe collisions.

What candidates needed to improve

- Candidates must understand the difference between molecular formulae, structured formulae and displayed formulae.
- Candidates must understand the meaning of the term observation since this does not require the name of a substance or an explanation about why a reaction takes place. The answer should focus on what would be observed, for example, colours of precipitate or the presence of bubbles.
- Candidates must be able to write ionic half-equations by ensuring they use the correct formula for an ion and appreciate that electrons are gained at the cathode and lost at the anode.
- Candidates must use the correct terminology when describing the formation of crystals from an aqueous solution.
- Candidates should focus on practising calculations involving the percentage of water of crystallisation from a given formula. The candidates were often not able to calculate the molar mass of formula such as $\text{ZnCl}_2 \cdot 3\text{H}_2\text{O}$.

Comments on specific questions

Section A

Question 1

(a) Comprehensive responses

- Many candidates recognised that Al_2O_3 is an amphoteric oxide.

Limited responses

- Some candidates gave compounds that were not oxides.

(b) Comprehensive responses

- Many candidates recognised that H_2 has a molecule containing only two atoms.

Limited responses

- Some candidates chose substances such as CuO and LiBr which were not molecules but ionic compounds.
- Other candidates gave molecules that had two elements chemically combined such as NH_3 or NH_2OH , rather than two atoms.

(c) Comprehensive responses

- Many candidates recognised NH_3 as a molecule with only 10 electrons.

Limited responses

- Some other candidates gave one of the other molecules in the list.

(d) Comprehensive responses

- Most candidates gave Al_2O_3 as a compound with an element having an oxidation number of +3.

Limited responses

- Some candidates did not give the full formula and gave Al or Al^{3+} as the answer.

(e) Comprehensive responses

- Most candidates chose C_3H_8 as an alkane.

Limited responses

- Some candidates gave C_2H_4 which is an alkene.

Question 2

(a) Comprehensive responses

- Some candidates were able to calculate the volume of oxygen and quoted the answer to three significant figures.
- Successful responses included all the working, including calculation of the amount in moles of KO_2 , followed by the amount in moles of oxygen and finally the volume of oxygen.

Limited responses

- Some candidates were not able to use the mole ratio to calculate the amount in moles of oxygen.
- Some candidates gave answers that had four significant figures rather than three.
- Many candidates did not correctly round intermediate calculated values and often truncated the numbers.

(b) Comprehensive responses

- Some candidates were able to deduce the formula for the superoxide ion as O_2^- .

Limited responses

- Many candidates gave answers that had only one oxygen atom such as O^- , O^{2-} and O^{4-} .
- Some candidates gave the formula for the peroxide ion instead of the superoxide ion.

(c) Comprehensive responses

- Some candidates were able to give the correct definition and highlighted the regular structure of positive and negative ions.

Limited responses

- Most candidates did not appreciate that a giant ionic lattice has a regular structure and often repeated the words given in the term giant ionic lattice.

(d) Comprehensive responses

- Most candidates were able to describe the separation, arrangement and motion of particles in solid carbon dioxide. These candidates often described the regular nature of tightly packed particles that could only vibrate.

Limited responses

- Some candidates did not appreciate the meaning of the term separation and described a method of separation rather than the distance between particles.
- Some candidates did not mention the regular arrangement or that the particles were in a lattice.

(e) Comprehensive responses

- Many candidates drew a correct dot-and-cross diagram.

Limited responses

- Some candidates drew diagrams with only one carbon atom and one oxygen atom.
- Some candidates drew single bonds between the carbon and oxygen atoms.

- Other candidates drew a structure that resembled the dot-and-cross diagram for carbon monoxide.

(f) Comprehensive responses

- Some candidates referred to weak intermolecular forces.

Limited responses

- Some candidates referred to weak bonds or weak covalent bonds within their answers.

Question 3

(a) Comprehensive responses

- Many candidates were able to draw the correct reaction profile diagram and labelled the reactant and the products and drew the correct arrow for the enthalpy change.

Limited responses

- Some candidates were able to label the axes and often candidates referred to rate of reaction as the y-axis and time as the x-axis.
- Some candidates did not draw an arrowhead on the enthalpy change line or drew two arrowheads.

(b) Comprehensive responses

- Most candidates stated that the activation energy was lowered.

Limited responses

- Some candidates mentioned an alternative pathway as well as the activation energy being lowered.

(c) Comprehensive responses

- Many candidates recognised that increasing the surface area increases the rate of reaction and/or allows a greater amount of toxic gases to react within the catalytic converter.

Limited responses

- Some candidates just focused on the catalyst and repeated the answer to **part (b)** about the activation energy being lowered.

(d) Comprehensive responses

- Some candidates appreciated that the particles are more crowded and often expressed this as more particles per unit volume or that the particles were closer together.
- Many candidates appreciated that the collision frequency was increased and often the answers mentioned effective or successful as well, for example, more successful collisions per second.

Limited responses

- Some candidates incorrectly stated that as the pressure increases that the particles move faster or have more kinetic energy.
- Some candidates referred to the chances of a collision increasing without referring to collision frequency.

(e) Comprehensive responses

- Many candidates appreciated that as the temperature increases the particles have more kinetic energy or move faster.
- Most candidates appreciated that there were more successful or more effective collisions. This answer was often qualified by reference to collision frequency as well.

Limited responses

- Some answers did not mention kinetic energy of the particles either missing out the words kinetic or particles.
- Some candidates only referred to collision frequency without mentioning successful, effective or more energetic collisions.

Question 4

(a) Comprehensive responses

- Some candidates listed accurate observations for the two electrolysis experiments.

Limited responses

- Many candidates listed the names of the products or wrote ionic equations rather than the observations.
- Some candidates gave imprecise observations particularly for the solid products, for example, just giving a colour rather than mentioning a solid was also formed.
- Some candidates referred to a gas being produced at the anode for the electrolysis using a graphite electrode rather than the observation of effervescence or bubbling.

(b) Comprehensive responses

- Some candidates were able to write at least one ionic half-equation.
- Candidates were more likely to be able to write the equation for the formation of barium than the equation for the formation of iodine.

Limited responses

- Many candidates included the electrons on the wrong side of the half-equations having the anode gaining electrons and the cathode losing electrons.
- Some candidates confused the element barium for bromine and as a result used Br^{2+} in the half-equation.

(c) (i) Comprehensive responses

- Most candidates knew the meaning of the term inert, and the most common answer was unreactive.

Limited responses

- A few candidates referred to inert being neutral rather than unreactive.

(ii) Comprehensive responses

- Many candidates gave the name platinum as an inert electrode.

Limited responses

- A few candidates gave graphite.

(d) (i) Comprehensive responses

- Some candidates appreciated that the oxidation number was +2.

Limited responses

- Many candidates gave the oxidation number as 2 or 2+.

(ii) Comprehensive responses

- The concept of OIL RIG was well known by most candidates.
- Many candidates appreciated that magnesium atoms were oxidised because they lost electrons.

Limited responses

- Many candidates thought that copper was reduced rather than copper ions being reduced.

Question 5

(a) Comprehensive responses

- Many candidates recognised that there would be bubbling.

Limited responses

- Most candidates did not mention that the zinc would disappear, and a colourless solution would be formed.
- Some candidates did not give an observation and stated that zinc chloride and hydrogen would be formed.

(b) Comprehensive responses

- Some candidates appreciated that the presence of excess zinc ensures that all of the hydrochloric acid is used up.

Limited responses

- Some candidates stated that the excess zinc ensures that the maximum amount of zinc chloride is made.
- Some other candidates thought that excess zinc was used to ensure all the zinc reacted rather than all of the acid.

(c) Comprehensive responses

- Candidates used a variety of different approaches to this question many of which were successful.
- Many candidates calculated the amount in moles of zinc, the amount of moles of HCl in the provided solution and then showed that either the amount of zinc was more than was needed or the amount of HCl was not sufficient.
- Some candidates calculated the mole ratio of the zinc and the HCl and showed that it was not 1 mole to 2 moles.
- Some other candidates calculated the mass of zinc needed to react with the provided HCl(aq) and showed that this was less than the zinc provided.
- Many candidates were able to effectively demonstrate their method by suitable working out.

Limited responses

- Some candidates often rounded the answers to one significant figure which was not appropriate for the numbers given in the question.
- Some candidates did not use the correct mole ratio in their calculations.

(d) Comprehensive responses

- Many candidates appreciated that the zinc is removed by filtration.

Limited responses

- Some candidates incorrectly chose evaporation.

(e) Comprehensive responses

- Some candidates were able to give a detailed method that included heating to make a saturated solution, cooling down the saturated solution and then filtering off the crystals washing with water and drying between folds of filter paper.

Limited responses

- Many candidates focused on how the aqueous zinc chloride was made rather than how the aqueous zinc chloride was used to make zinc chloride crystals.
- Many candidates gave imprecise details, and it was not always obvious that the order of the processes described was correct.
- Some candidates did not heat to get a saturated solution and instead evaporated the solution to dryness.
- Other candidates did not describe filtering off crystals and/or how the crystals were dried.

(f) Comprehensive responses

- Some candidates were able to calculate the percentage by mass of the water of crystallisation. These candidates often showed clear working out.

Limited responses

- Many candidates were unable to calculate the molar mass of the hydrated crystals in particular the meaning of $3\text{H}_2\text{O}$ part of the formula. Candidates often thought that the molar mass of $3\text{H}_2\text{O}$ was 22 rather than 54 g mol^{-1} .

(g) Comprehensive responses

- Some candidates were able to describe the observations when aqueous ammonia is added to aqueous zinc chloride. Complete responses described the formation of a white precipitate that redissolves in excess ammonia to give a colourless solution.

Limited responses

- Some candidates just referred to a soluble precipitate and did not mention the colour of the precipitate or of the solution made.

Question 6

(a) Comprehensive responses

- Some candidates appreciated that both metals contain mobile electrons.

Limited responses

- Many candidates referred to the presence of free electrons or delocalised electrons and neglected to include that the electrons were mobile.
- Some candidates referred to mobile ions rather than mobile electrons.

(b)(i) Comprehensive responses

- Some candidates were able to give one difference in physical properties. This difference was often that copper had a higher density than aluminium.

Limited responses

- Many candidates confused physical and chemical properties of the two metals.
- Some candidates gave imprecise answers such as the single word density that was not qualified.

(ii) Comprehensive responses

- Many candidates were able to give at least one difference in chemical property. Typically, candidates referred to the formation of coloured compounds by copper, variable oxidation states of copper and catalytic property of copper.

Limited responses

- Many candidates confused the physical and chemical properties of the two metals.

(c)(i) Comprehensive responses

- Some candidates appreciated that zinc is added to copper to make brass.

Limited responses

- Some candidates gave nickel or iron rather than zinc.

(ii) Comprehensive responses

- Some candidates appreciated that the particles in brass were of different sizes.

Limited responses

- Many candidates were unable to explain why brass is harder than copper because they did not mention that the layers of atoms or ions cannot slide over each other easily. Answers often referred to atoms or ions sliding rather than layers.

(d)(i) Comprehensive responses

- Some candidates described the presence of an oxide layer on the surface of aluminium and some of these candidates then explained that the layer was non-porous or impermeable to water and/or oxygen.

Limited responses

- Some candidates just referred to a layer of oxygen rather than of aluminium oxide.
- Some candidates referred to a protective layer on the surface of aluminium and did not explain that the layer stops water and/or air reaching the surface of the aluminium.

(ii) Comprehensive responses

- Many candidates were able to give a suitable use for aluminium, making aircraft or making overhead electricity cables being the most popular answers.
- Candidates were often able to link the use to a suitable property with low density being the most common answer.

Limited responses

- Some candidates gave examples of food containers even though these had been given in an earlier part of the question.
- Some candidates were imprecise in their description of overhead electricity cables referring to just electricity cables or unqualified wires.

(e) (i) Comprehensive responses

- Some candidates gave answers that suggested the energy requirement for the process was lowered for example referring to a lower operating temperature or the lowering of the melting point of aluminium oxide.

Limited responses

- Some candidates just referred to the lowering of the melting point without stating which substance had its melting point lowered.
- Some candidates incorrectly stated that the melting point of aluminium was lowered.
- Other candidates also referred to boiling points being reduced rather than melting points.

(ii) Comprehensive responses

- Some candidates were able to give a detailed explanation involving carbon reacting with oxygen to make carbon dioxide.

Limited responses

- Some candidates appreciated that the carbon anode reacts and did not necessarily state what it reacted with or what was formed.
- Other candidates just described the corrosion or erosion of the anode and did not mention any chemical reaction.

Question 7

(a) Comprehensive responses

- Many candidates were able to draw the structure of poly(chloroethene). Often these candidates used the convention of using 'n' to represent a repeating unit of the polymer.

Limited responses

- Some candidates gave the structure of polyethene rather than poly(chloroethene).
- Other candidates included a double bond in the structure either as just the structure of the monomer or as part of a longer chain.

(b) Comprehensive responses

- Some candidates were able to give one correct property typically the polymer is non-biodegradable.

Limited responses

- Many candidates did not appreciate that non-biodegradable and does not decompose are really the same property.
- Some candidates appreciated that the polymer was insoluble and did not mention that it is insoluble in water.
- Many candidates gave irrelevant properties such as referring to the toxic nature of combustion products.

(c) (i) Comprehensive responses

- Many candidates gave carbon dioxide as the greenhouse gas.

Limited responses

- Some candidates gave methane even though this is not formed by the combustion of the polymer.

(ii) Comprehensive responses

- Many candidates gave carbon monoxide as the toxic gas. A few candidates gave hydrogen chloride since the polymer contained chemically combined chlorine.

Limited responses

- Some candidates gave carbon dioxide.

(d) Comprehensive responses

- Most candidates were able to show sufficient working out to show that the enthalpy change was $+101 \text{ kJ mol}^{-1}$.

Limited responses

- A few candidates were able to calculate the energy associated with bond breaking and bond making and did not include the correct mathematical signs.

Question 8

(a) Comprehensive responses

- Some candidates appreciated that the reaction involved bacterial oxidation and sometimes included oxygen as a reactant.

Limited responses

- Many candidates were not able to write the symbol equation. The candidates did not write the correct formula for ethanoic acid or neglected to include water as a product.
- Some candidates confused this reaction with the manufacture of ethanol and gave conditions such as acid catalysts, high temperature and high pressure.
- Some candidates gave conditions more appropriate for the reaction in a laboratory rather than the manufacture of ethanoic acid and used acidified potassium manganate(VII) as the oxidising agent.

(b) Comprehensive responses

- Some candidates drew the displayed formula for butanoic acid.

Limited responses

- Some candidates did not show the carboxylic acid group as fully displayed writing —OH rather than —O—H .
- Some candidates drew a structural formula that was not fully displayed.

(c) Comprehensive responses

- Many candidates gave the correct definition for a structural isomer.

Limited responses

- Some candidates used the idea of the same chemical formula rather than the same molecular formula.

(d)(i) Comprehensive responses

- Some candidates were able to write the correct name of the ester.

Limited responses

- Some candidates knew the correct ester and made minor errors in spelling or included a position number in the middle of the name.

(ii) Comprehensive responses

- Some candidates were able to draw the structure of the ester.
- Some candidates drew a displayed formula and others a structural formula.

Limited responses

- Some candidates could not draw a correct ester linkage and included a hydroxyl group at the end of the butyl group.

(iii) Comprehensive responses

- Some candidates appreciated the need of a catalyst, and some gave the generic name of an acid catalyst and others referred to sulfuric acid.
- Some candidates referred to heating the mixture.

Limited responses

- Some candidates gave temperatures well in excess that needed for esterification.

(e)

Comprehensive responses

- Some candidates were able to give the molecular formula for octanoic acid.

Limited responses

- Many candidates gave a formula which were not a molecular formula since the carboxylic acid group was shown as COOH or CO₂H.
- Other candidates gave formulae that had nine carbon atoms rather than eight.
- Other candidates gave a structural formula.

CHEMISTRY

Paper 5070/32 Practical Test

Key messages

What candidates did well

- Many candidates were able to obtain appropriate results from their practical work.
- Many candidates were able to describe a plan for a titration experiment clearly.

What candidates needed to improve

- Candidates should have experience of a range of practical experiments that enable them to understand what is being described in the investigations in the paper.
- Candidates should be familiar with the range of equipment used in general laboratory work as described in the syllabus, be able to recognise these and use them correctly and be able to select suitable equipment for use in particular contexts.
- Candidates need to read the introductory information carefully so as to understand the experiments that are described.
- Candidates need to make more effective use of the qualitative analysis notes provided in the paper.
- Practical based science papers often require candidates to draw graphs. Some candidates need to develop this skill to a higher level.

Comments on specific questions

Section A

Question 1

(a) (i) Comprehensive responses

- Most candidates were able to record five times which showed an increase as the concentration of acid decreased.

Limited responses

- Some candidates did not take note of the instruction to record the time to the nearest second.

(ii) Comprehensive responses

- Candidates needed to decide how they knew that the reaction was complete. Most chose to use the point when effervescence ended and some chose the point when all of the solid had reacted.

Limited responses

- Some candidates did not mention that they had to wait until **all** of the solid had reacted.
- Some candidates thought that simply observing effervescence indicated that the reaction was complete.

(iii) Comprehensive responses

- The quality of the graphs drawn was quite variable.
- It is important that candidates read the instructions fully so as to realise that they needed to label the axes.
- Candidates found it easier to plot the points when they had selected a sensible scale based on the range of results they had obtained.
- Sometimes it is appropriate to start the y-axis at a value other than zero.

Limited responses

- Some candidates chose a non-linear scale for time and simply put their five values equidistant on the y-axis
- Some candidates chose scales in which each small square represented a fractional value, such as 4.6 seconds, which made accurate plotting of points less straightforward.

(iv) Comprehensive responses

- A best fit curved line should be smooth and show the correct trend for the data.
- The curve is dependent on the results obtained and as a general rule the line should be evenly spread between data points.

Limited responses

- Some candidates joined the points in a series of dot-to-dot straight lines instead of a curve.
- Some candidates had very thick or multiple-line curves which were inappropriate.

(v) Comprehensive responses

- This question tested candidates' skills in reading a value from a graph.
- The answer was dependent on the line which the candidate had drawn in part **(a)(iii)**.

Limited responses

- The answer to this question was either correct or incorrect based on the graph drawn.
- When reading from a graph, candidates should give values within $\pm$ half a small square.

(b) Comprehensive responses

- Candidates needed to read the information given in the stem of the question so as to understand clearly what was taking place in order to identify inaccuracies and suggest improvements.
- The most common correct answers were recognising that the measuring cylinder used did not give an accurate value for the volumes and that a volumetric pipette or burette would be more accurate.
- Only a few candidates recognised that the greatest variation in the experiment is due to the way in which the end point is detected as this is quite subjective. It can be improved by using a more quantitative endpoint such as measuring a mass loss or a volume of gas collected.

Limited responses

- Many candidates thought that there were issues with using black paper and suggested using white paper instead. This may have been because they were familiar with the sulphur-clock experiment using an X on white paper for the end point. In this experiment, the mixture is going from cloudy to clear whereas in the sulphur-clock experiment, it is going from clear to cloudy.
- Some candidates had not understood that using different volumes of acid and water whilst keeping the total volume constant was a way of changing the concentration. They therefore suggested keeping the volume of acid or water constant as an improvement.

(c) (i) Comprehensive responses

- The answer to this question was either correct or incorrect.

Limited responses

- Few candidates knew how to scale the initial concentration based on the volume of water used.
- Candidates should have been aware that the concentration of the acid must be lower than the initial concentration, because water had been added.
- Many candidates gave an answer which was higher than the initial concentration of the acid.

(ii) Comprehensive responses

- Answers that demonstrated a clear understanding recognised that the rate increases with concentration.
- To make this conclusion candidates needed to recognise that adding water reduced the concentration and that when the time taken for the reaction is shorter then the rate of reaction is greater.

Limited responses

- Some candidates confused rate with time concluding that rate decreased when concentration increased.
- The question required candidates to refer to the data provided and not just give an answer based on collision theory.

Question 2

(a) (i) Comprehensive responses

- Candidates needed to describe a hazard in the experiment and relate this to a precaution that could be taken to minimise the risk.
- Some candidates recognised that if hot solid came out of the tube then it could cause injury if it landed on the person doing the experiment and suggested a way in which the likelihood of this could be reduced.
- Some candidates recognised that in a decomposition reaction, gases may be produced which could be harmful and suggested ways of avoiding inhaling fumes.

Limited responses

- Stating that heat is used in an experiment is too vague and there needs to be a description of what effect the heat has.
- Many responses were too vague such as 'it gets hot', 'danger of burning', 'breaking the tube' 'apparatus may fall over', etc.
- Use of gas masks in general laboratory experiments is not a normal precaution. There are other ways that are more suitable for reducing risk. Use of a fume cupboard or ensuring good ventilation are suitable methods in a school laboratory.

(ii) Comprehensive responses

- Candidates suggested a Bunsen burner, spirit lamp or electric heater as suitable apparatus for heating in a laboratory. Sometimes the apparatus named did not correspond to the apparatus that the supervisor said had been provided.

Limited responses

- Some candidates misunderstood the question and named the apparatus which was heated instead of the apparatus used to heat.

(iii) Comprehensive responses

- Some candidates gave a full description of the changes that take place when the solid is heated.

Limited responses

- Many candidates gave incomplete descriptions, in particular omitting the formation of water vapour, which, if the tube was heated gently as required, condenses at the neck of the tube.

(iv) Comprehensive responses

- Candidates generally did not obtain the appropriate colour changes for litmus consistently.

Limited responses

- Many candidates observed no change with either type of litmus paper.

(b) (i) Comprehensive responses

- Many candidates knew to use universal indicator to measure the pH.

Limited responses

- Candidates suggested alternative indicators such as litmus, which were unsuitable for measuring pH.

(ii) Comprehensive responses

- Many candidates gave an appropriate colour and corresponding pH for this acid salt.

Limited responses

- In a practical paper it is important that candidates understand the difference between an observation and a conclusion.
- Some candidates stated that 'aqueous **C** is acidic' or 'it is a strong acid'. These are conclusions rather than observations so do not answer the question.
- Sometimes the pH value given did not match the colour that they described. Candidates were provided with a colour chart to enable them to determine the pH.

(iii) Comprehensive responses

- Many candidates described the formation of the red-brown precipitate, which is insoluble in excess, sodium hydroxide and correctly concluded that iron(III) ions were present.

Limited responses

- Some candidates did not use the term precipitate and instead simply stated that the mixture turned red-brown.

(b)(iv) Comprehensive responses

- Many candidates observed the white precipitate and correctly concluded that a sulfate ion was present.

Limited responses

- Some candidates thought that the precipitate was yellow, possibly because they did not leave the mixture to stand and were looking at the precipitate through the yellow solution. Some then went on to suggest that an iodide was present.

Question 3

Comprehensive responses

- Candidates read the instructions and wrote about each aspect of the question, the apparatus used, the method followed and how a conclusion could be reached.
- Candidates recognised from the information provided that the method required for this plan involved a titration.
- A full description of a titration was given including the use of a burette and pipette, a named suitable indicator, the techniques needed to obtain accurate results and the measurements that need to be made.
- The guidance provided stated that no calculation was required. The conclusion needed to relate to the measurements taken and should have been linked to the volume of hydrochloric acid or aqueous ammonia depending on which one was placed in the burette.

Limited responses

- Some candidates decided that a method other than a titration was suitable. These alternative methods included measuring pH, producing a salt or collecting a volume of ammonia gas.
- Most candidates recognised that they needed to do a reaction between the samples of ammonia and dilute hydrochloric acid and repeated their method for each of the three samples.
- Many candidates thought that universal indicator was suitable for a titration. Universal indicator does not always give a distinct endpoint in a titration. Other named indicators are more appropriate.
- Few candidates described suitable ways for achieving accurate results.
- Some candidates thought that when hydrochloric acid is added to aqueous ammonia, then ammonia gas is evolved and can be collected.
- Many candidates tried to describe calculations in a vague manner despite the fact that the guidance said this was not required.
- Candidates who used an alternative method were generally unable to link this in any meaningful way to the conclusion required.

CHEMISTRY

Paper 5070/41
Alternative to Practical

Key messages

What candidates did well

- Most candidates were familiar with the process of chromatography and were able to predict the distribution of spots correctly.
- The graph drawing question was completed successfully in most cases. Candidates generally labelled axes, used appropriate scales, plotted points and drew lines of best fit correctly.
- Most candidates seem to be familiar with the 'Notes for use in qualitative analysis' sheet and used it successfully on several occasions.
- Most candidates wrote a clear and comprehensive investigation plan, which would give valid results.

What candidates needed to improve

- Clarity of responses. Candidates should be specific regarding which piece of apparatus or chemical they are referring to, rather than the use of 'it'.
- Candidates need to make sure that their answer is clear and could not be easily misinterpreted.
- The text in the question stem often gives information that candidates need to use. Candidates should take time to read the information given. Once a candidate finds relevant information in the question stem, they need to make sure that their answer expands on this information, rather than simply repeating the given facts.
- Candidates need to be clear about what the different command words mean. When the command word is 'explain' they need to be thinking about the 'why' and 'how' rather than just describing data or an observation.
- When using the 'Notes for use in qualitative analysis', candidates should re-read the question to make sure they are obtaining the correct information from the sheet.

Comments on specific questions

Question 1

(a) Comprehensive responses

- Many candidates recognised that if the dyes were below the solvent level, they would mix with the solvent and fail to rise up the paper.

Limited responses

- Some candidates referred to the baseline itself dissolving in the solvent. The baseline is always drawn in pencil, so this would not occur.
- Some candidates referred to 'it' dissolving in the solvent. The question is asking about the baseline, so 'it' would refer to the baseline. This is incorrect, the baseline would not dissolve.

(b) Comprehensive responses

- Most candidates were clear with the wording of their answer. They recognised that two spots would indicate the presence of two coloured compounds and one spot would indicate the presence of just one coloured compound.

Limited responses

- Some candidates were not specific enough with their wording. A common answer was that **A** and **C** are pure, **B** is not. This answer did not explain why **B** would have two spots (rather than three or four).
- Similarly, some candidates answered, '**B** is a mixture of two coloured compounds, **A** and **C** are not'. This answer explains the presence of two spots for **B**, and not why there would only

be one spot each for **A** and **C**. This wording could indicate that **A** and **C** are mixtures of more than two coloured compounds.

(c) Comprehensive responses

- Most candidates realised that if the spot at **D** has not moved, it is because **D** is insoluble in the solvent.

Limited responses

- Some candidates thought that there was a 'reaction' between **D** and the solvent, which did not occur.

(d) Comprehensive responses

- Many excellent responses explained that the presence of a lid stops the solvent evaporating.

Limited responses

- Candidates sometimes thought the lid was there to stop impurities entering the beaker.
- Some candidates said the lid would stop the dyes, rather than the solvents, evaporating.

(e) Comprehensive responses

- Most candidates clearly drew two spots on Figure 1.1, one spot being level with the spot for dye **A** and one level with the spot for dye **C**.

Limited responses

- Some candidates drew just one spot, halfway between the heights of the spots for **A** and **C**.

Question 2

(a) (i) Comprehensive responses

- The majority of candidates recognised that they just had to copy the value from the balance in Figure 2.1.

Limited responses

- A few candidates did not write the correct value, there didn't seem to be a pattern in the incorrect values given as answers.

(ii) Comprehensive responses

- Most candidates correctly added the value of 2.0 g (given in the question stem) to their answer from **2(a)(i)**.

Limited responses

- Some candidates did not realise that the mass of calcium carbonate was in the question stem. They calculated an answer by trying to work out a pattern from the table, often coming up with an incorrect value of 123.4 g.

(iii) Comprehensive responses

- Many candidates realised that the total mass is constant because the reaction has finished.

Limited responses

- Candidates sometimes did not follow the command word, 'explain'. For example, some candidates said, 'because the mass does not change', or 'because the mass has reached its minimum'. Both statements describe the data, and do not explain why it is like that.

(iv) Comprehensive responses

- Many candidates plotted excellent graphs. They labelled both axes, with units, gave a suitable scale on the x axis and accurately plotted all points.
- While candidates did not have to add values to the y axis (as the scale was already there), some candidates did correctly add intermediate values, which made it easier to plot their points.

Limited responses

- Some candidates labelled the axes 'mass' and 'time' and missed out the units. The units to use were given in Table 2.1.
- Candidates sometimes made a mistake while trying to add intermediate values to the y axis, making the plotting of points very difficult.

(v) Comprehensive responses

- Most candidates drew a clear, smooth curve of best fit.

Limited responses

- A few candidates drew 'dot-to-dot' lines with a ruler, rather than a smooth hand-drawn line.

(b)(i) Comprehensive responses

- Many candidates recognised that, although the gas needs to be able to leave the flask, the liquid needs to remain in the flask. The conical flask is not left open to stop the liquid escaping.

Limited responses

- Some candidates incorrectly stated that the flask was not left open to stop the gas escaping.
- Other candidates were too vague in their answers. For example, by saying, 'to stop the contents escaping'. This answer is not specific enough, as carbon dioxide gas and calcium carbonate solid are both contents of the flask in addition to the liquid.

(ii) Comprehensive responses

- Most candidates correctly stated that the cotton wool plug was used to allow carbon dioxide to escape.

Limited responses

- Some candidates said that the cotton wool plug would 'trap', 'absorb', or 'take up' the gas. All these answers are incorrect as they imply that the gas is remaining in the cotton wool rather than escaping.

(c) Comprehensive responses

- Many candidates realised that the decrease in mass was due to the loss of carbon dioxide gas from the flask.

Limited responses

- The equation for the reaction is given in the question stem and states that carbon dioxide is produced. Some candidates did not appreciate that a gas was being produced and instead related the decrease in mass to an incorrect reason, such as the calcium carbonate being used up.
- Some candidates who realised that the loss was due to carbon dioxide were not clear in their explanation that the carbon dioxide leaves the flask. The fact that carbon dioxide is produced is given in the equation in the question stem. Candidates had to make it clear that the loss in mass is due to this gas leaving the flask.

(d) Comprehensive responses

- Some excellent responses clearly described the drawing of a tangent and the calculation of the gradient of the tangent. If the description of the calculation of a gradient was described, it was clearly a difference in mass divided by a difference in time.

Limited responses

- Rather than describing the calculation of the gradient as being a difference in mass divided by a difference in time, some candidates stated that a single mass value had to be divided by a single time value.

(e) Comprehensive responses

- Most candidates successfully described the relationship between concentration and rate.
- Some candidates also successfully explained how the graph shows this relationship, by referring to the gradient decreasing.

Limited responses

- Some candidates described the relationship between reaction time and concentration, rather than rate and concentration, as the question asked.
- Candidates did not use the graph in the explanation. Candidates instead related the relationship to the collision theory.

Question 3

(a) Comprehensive responses

- Many candidates read the question stem carefully and recognised that bromine would turn from orange to colourless in the presence of an unsaturated carboxylic acid.

Limited responses

- Some candidates gave only one half of the colour change, for example, 'it will turn colourless'.
- Other candidates looked up 'bromide ions' in the 'Notes for use in qualitative analysis' and gave the answer as 'cream precipitate'.

(b)(i) Comprehensive responses

- Through reading the question stem, candidates realised that a gas is produced and, if a gas is produced, effervescence will be observed.

Limited responses

- Some candidates realised that zinc is involved, then looked at the 'Notes for use in qualitative analysis' sheet and said that a white precipitate would be produced.
- Some candidates gave the observation of the hydrogen gas test, rather than the observation of a gas being produced.

(ii) Comprehensive responses

- Many candidates gave excellent responses. They got the information from the question stem that zinc metal is being reacted with an acid. They then realised that hydrogen gas would be produced and then used the 'Notes for use in qualitative analysis' sheet to give the correct test and result for the hydrogen test.

Limited responses

- While some candidates gave an incorrect gas, for example carbon dioxide, they did then use the 'Notes for use in qualitative analysis' sheet to give a correct test and result for that gas.

(c) Comprehensive responses

- Some candidates took time to read and understand the information in the question. They realised that solution X was made by reacting zinc with an acid. They identified that this would give a solution containing zinc ions and correctly used the 'Notes for use in qualitative analysis' sheet to provide the correct observations.

Limited responses

- Some candidates did not get the information from the question stem, so did not realise that they had to give the observations for zinc ions with sodium hydroxide.
- While some candidates did obtain the correct observations from the 'Notes for use in qualitative analysis' sheet, they didn't then specify 'precipitate' in their answer, for example, simply saying, 'it will go white'.

(d)(i) Comprehensive responses

- Many excellent candidates recognised that cobalt chloride paper turning pink is a positive result for water.

Limited responses

- Some candidates did not know the name of the gas that can be tested for with cobalt chloride paper, and gave incorrect gases, the most common of which were hydrogen or chlorine.

(ii) Comprehensive responses

- Some candidates realised that if water was produced from solid Y on heating, then solid Y must have contained water of crystallisation.

Limited responses

- Rather than stating that Y becomes anhydrous, some candidates stated that Y is anhydrous.
- Some candidates simply stated that water is produced. This knowledge was assessed in **3(d)(i)**. In this question they needed to think about where that water has come from.

(e) (i) Comprehensive responses

- Most candidates successfully used the 'Notes for use in qualitative analysis' sheet and looked up which gas is tested for with acidified potassium manganate(VII).

Limited responses

- Some candidates gave incorrect gas names.

(ii) Comprehensive responses

- Most candidates used the 'Notes for use in qualitative analysis' sheet to correctly identify the test and positive result for sulfate ions.

Limited responses

- Some candidates read the question incorrectly and rather than giving a test for sulfate ions, they gave a test for sulphur dioxide gas.

(f) (i) Comprehensive responses

- Most candidates used the 'Notes for use in qualitative analysis' sheet to correctly identify that iron(II) ions give a green precipitate with sodium hydroxide, that is insoluble in excess.

Limited responses

- Some candidates seemed to use the 'Notes for use in qualitative analysis' sheet and read down the table as far as the first cation that gives a green precipitate with sodium hydroxide. They then gave the incorrect answer of chromium(III).

(ii) Comprehensive responses

- Many candidates clearly explained that the colour change is due to the precipitate being oxidised.

Limited responses

- Some candidates gave a simple statement, 'because it contains iron(II)' rather than an explanation of the reason for the colour change.

Question 4

Comprehensive responses

- Many candidates gave excellent clear, detailed plans. The most comprehensive answers included:
 - Comprehensive lists of apparatus.
 - Bullet pointed or numbered steps.
 - Very clear indications of what temperatures were being taken and when.
 - Descriptions of repetitions and the reasons for the repetitions.
 - Clear description of control variables.
 - A well-worded conclusion specific to their plan.

Limited responses

- While the majority of candidates attempted to write a plan, some missed key details, such as:
 - 'Thermometer' was often not named.
 - Some candidates talked about the time taken for the ice to melt. The question clearly stated that the investigation was to do with the temperature changes, not the time.
 - For those candidates that did refer to temperature, they sometimes only took one temperature, not the initial and lowest.
 - While repeating was often mentioned, the detail and reason was missed.
 - Some candidates gave a good plan, then did not give a conclusion. Or if a conclusion was given, it was not related to the question.

CHEMISTRY

Paper 5070/42 Alternative to Practical

Key messages

What candidates did well

- Many candidates were able to describe expected observations based on the methods provided.
- Many candidates were able to describe a plan for a titration experiment clearly.

What candidates needed to improve

- Candidates should have experience of a range of practical experiments that enable them to understand what is being described in the investigations described in the paper.
- Candidates should be familiar with the range of equipment used in general laboratory work as described in the syllabus, be able to recognise these from diagrams and be able to select suitable equipment for use in particular contexts.
- Candidates need to read the introductory information carefully so as to understand the experiments that are described.
- Candidates need to improve their use of the qualitative analysis notes provided in the paper.
- Practical based science papers often require candidates to draw graphs. Some candidates need to develop this skill to a higher level.

Comments on specific questions

Section A

Question 1

(a) (i) Comprehensive responses

- Many candidates knew that this was a condenser. It was not essential to refer to it as a Leibig condenser.

Limited responses

- A few candidates named other pieces of apparatus such as test-tube or fractionating column.
- Some answers were too vague such as condensing tube.
- This type of question tests a candidate's knowledge of the technical name for apparatus listed in the syllabus.

(ii) Comprehensive responses

- Candidates were aware of the fact that there is water circulating in the outside tube of the condenser which cooled the vapours in the inner tube.

Limited responses

- Candidates referred to water being condensed and collected instead of the vapours of the alkanes.
- Candidates often only referred to condensing the vapours rather than cooling the vapours.

(b) Comprehensive responses

- Ideally candidates should have referred to the difference in boiling points.
- Simply stating that the property is the boiling point was sufficient.

Limited responses

- The fact that the alkanes may have low boiling points is not the property that allows them to be separated.
- Some candidates incorrectly gave more than one property.

(c) Comprehensive responses

- Some candidates gave detailed responses explaining that the lower boiling point alkane is collected first and that at this point the temperature recorded at the thermometer remains constant until all of this alkane has been collected. They were then able to explain that the temperature at the thermometer rises until the next boiling point is reached and the second alkane is collected. Some also referred to the fact that the final alkane can be obtained as the remaining liquid in the round-bottom flask. They also realised that different conical flasks are needed in order to separate the alkanes.

Limited responses

- Candidates often referred to the temperature in the round-bottom flask or in the fractionating column rather than at the outlet to the condenser where the thermometer is located.
- Candidates quite often referred to collecting the first alkane without reference to the fact that this one has the lowest boiling point.
- Few candidates recognised the need to replace the conical flask each time an alkane is collected.

Question 2

(a) (i) Comprehensive responses

- Candidates needed to read the information given in the stem of the question so as to understand clearly what was taking place. This enabled them to identify the fact that carbon dioxide is produced and therefore effervescence occurs when the reaction is happening and will stop when the reaction is complete. Candidates could also suggest that all of the calcium carbonate was used up and the black paper becomes clearly seen through the aqueous solution.

Limited responses

- Candidates who did not appear to fully understand the method, suggested that the completion of the reaction was linked to the volume of acid used.
- Some candidates thought that simply observing effervescence indicated that the reaction was complete.

(ii) Comprehensive responses

- The quality of the graphs drawn was quite variable.
- It is important that candidates read the instructions fully so as to realise that they needed to label the axes.
- Candidates found it easier to plot the points when they had selected a sensible scale. The data was such that selecting a scale where each small square was five seconds produced a good graph.

Limited responses

- Some candidates chose a non-linear scale for time by using ten small squares for each of the data points for time given in the table.
- Some candidates chose scales in which each small square represented a fractional value, such as 4.6 seconds, which made accurate plotting of points less straightforward.

(iii) Comprehensive responses

- A best fit curved line should be smooth and show the correct trend for the data.
- A variety of interpretations of the data were possible and some candidates chose to consider the value at 30 cm³ as an anomaly so as to obtain a smooth curve.

Limited responses

- Some candidates joined the points in a series of dot-to-dot straight lines instead of a curve.
- Some candidates had very thick or multiple-line curves which were inappropriate.

(iv) Comprehensive responses

- This question tested candidates' skills in reading a value from a graph.
- The answer was dependent on the line which the candidate had drawn in part **(a)(iii)**.

Limited responses

- The answer to this question was either correct or incorrect based on the graph drawn.
- When reading from a graph candidates should give values within $\pm$ half a small square.

(b) Comprehensive responses

- As with part **(a)(i)**, candidates needed to read the information given in the stem of the question so as to understand clearly what was taking place, in order to identify inaccuracies and suggest improvements.
- The most common correct answers were recognising that the measuring cylinder used did not give an accurate value for the volumes and that a volumetric pipette or burette would be more accurate.
- Only a few candidates recognised that the greatest variation in the experiment is due to the way in which the end point is detected as this is quite subjective. It can be improved by using a more quantitative endpoint such as measuring a mass loss or a volume of gas collected.

Limited responses

- Many candidates thought that there were issues with using black paper and suggested using white paper instead. This may have been because they were familiar with the sulphur-clock experiment using an X on white paper for the end point. In this experiment the mixture is going from cloudy to clear whereas in the sulphur-clock experiment it is going from clear to cloudy.
- Some candidates had not understood that using different volumes of acid and water whilst keeping the total volume constant was a way of changing the concentration. They therefore suggested keeping the volume of acid or water constant as an improvement

(c) (i) Comprehensive responses

- The answer to this question was either correct or incorrect.

Limited responses

- Few candidates knew how to scale the initial concentration based on the volume of water used.
- Candidates should have been aware that the concentration of the acid must be lower than the initial concentration because water had been added.
- Many candidates gave an answer which was higher than the initial concentration of the acid.

(ii) Comprehensive responses

- Answers that demonstrated a clear understanding recognised that the rate increases with concentration.
- To make this conclusion, candidates needed to recognise that adding water reduced the concentration and that when the time taken for the reaction is shorter then the rate of reaction is greater.

Limited responses

- Some candidates confused rate with time concluding that rate decreased when concentration increased.
- The question required candidates to refer to the data provided and not just give an answer based on collision theory.

Question 3

(a) (i) Comprehensive responses

- Candidates needed to describe a hazard in the experiment and relate this to a precaution that could be taken to minimise the risk.
- Some candidates recognised that if hot solid came out of the tube then it could cause injury if it landed on the person doing the experiment and suggested way in which the likelihood of this could be reduced.
- Some candidates recognised that in a decomposition reaction, gases may be produced which could be harmful and suggested ways of avoiding inhaling fumes.

Limited responses

- Stating that heat is used in an experiment is too vague and there needs to be a description of what effect the heat has.
- Many responses were too vague such as 'it gets hot', 'danger of burning', 'breaking the tube' 'apparatus may fall over', etc.
- Use of gas masks in general laboratory experiments is not a normal precaution. There are other ways that are more suitable for reducing risk. Use of a fume cupboard or ensuring good ventilation are suitable methods in a school laboratory.

(ii) Comprehensive responses

- Candidates suggested a Bunsen burner, spirit lamp or electric heater as suitable apparatus for heating in a laboratory.

Limited responses

- Some candidates misunderstood the question and named the apparatus which was heated instead of the apparatus used to heat.

(iii) Comprehensive responses

- Candidates needed to link the observations described to conclusions that could be made from them.
- The pink colour of the solid and the fact that it turned yellow suggests that a transition ion is present.
- The forming of a solution which turned to a solid on further heating suggested the presence of water. Some candidates were able to recognise that this would have been due to the presence of water of crystallisation in the solid.
- Some candidates recognised that this would be a decomposition reaction.

Limited responses

- The question was not often answered well.
- Many candidates thought that the yellow colour was a result of sodium ions being present, possibly confusing this with a flame test.
- Many candidates thought that the yellow colour was a result of iodide ions being present, possibly confusing this with the yellow precipitate formed when iodide reacts with silver nitrate.

(iv) Comprehensive responses

- Candidates who make use of the notes for qualitative analysis would find this question straight forward.

Limited responses

- Many candidates described the effect of ammonia on litmus correctly.
- Fewer candidates recognised the fact that ammonia production when a solid is heated, is an indication that ammonium ions are present.
- Some candidates concluded that ammonia gas was produced and this was given in the question so was not an appropriate answer.
- Some candidates concluded that a nitrate ion was present as nitrates may also produce ammonia under different conditions.

(b)(i) Comprehensive responses

- Candidates needed to simply describe the use of universal indicator.

Limited responses

- As a general rule candidates should not write more than one contradictory answer.
- Candidates should name one indicator only; naming additional indicators is unnecessary.
- Many candidates suggested litmus paper. Although this detects acid and alkali it does not measure pH.

(ii) Comprehensive responses

- Candidates described an appropriate colour that is shown by universal indicator at pH 2.

Limited responses

- In a practical based paper, it is important that candidates understand the difference between an observation and a conclusion.
- Many candidates stated that 'aqueous **C** is acidic' or 'it is a strong acid'. These are conclusions rather than observations so do not answer the question.

(iii) Comprehensive responses

- As in part **(a)(iv)** candidates who make use of the notes for qualitative analysis would find this question straight forward. Candidates should use the descriptions provided in these notes rather than relying on memory so as to ensure that their descriptions are complete. For example describing the precipitate as 'red-brown' rather than 'brown'.

Limited responses

- Some candidates confused iron(III) with iron(II) and therefore described the wrong observations.

(iv) Comprehensive responses

- This question required candidates to realise that the original solution was yellow and that a white precipitate observed through a yellow solution may appear to be yellow. Allowing the precipitate to settle to the bottom of the solution reveals its true colour.

Limited responses

- There were a wide range of incorrect attempts to explain these observations. Many candidates thought that a yellow precipitate was formed first and that this changed to a white precipitate later. They then gave various suggestions as to what might have caused this.
- Some candidates thought the apparent yellow precipitate was caused by the presence of iodide ions, possibly confusing this test with the silver nitrate test.

(v) Comprehensive responses

- The answer to this question was either correct or incorrect.
- Candidates recognised the test for a sulfate from the qualitative notes.

Limited responses

- Some candidates incorrectly suggested more than one ion.
- Some candidates wrote an incorrect formula for the ion.

Question 4

Comprehensive responses

- Candidates read the instructions and wrote about each aspect of the question, the apparatus used, the method followed and how a conclusion could be reached.
- Candidates recognised from the information provided that the method required for this plan involved a titration.
- A full description of a titration was given including the use of a burette and pipette, a named suitable indicator, the techniques needed to obtain accurate results and the measurements that need to be made.
- The guidance provided stated that no calculation was required. The conclusion needed to relate to the measurements taken and should have been linked to the volume of hydrochloric acid or aqueous ammonia depending on which one was placed in the burette.

Limited responses

- Some candidates decided that a method other than a titration was suitable. These alternative methods included measuring pH, producing a salt or collecting a volume of ammonia gas.
- Most candidates recognised that they needed to do a reaction between the samples of ammonia and dilute hydrochloric acid and repeated their method for each of the three samples.
- Many candidates thought that universal indicator was suitable for a titration. Universal indicator does not always give a distinct endpoint in a titration. Other named indicators are more appropriate.
- Few candidates described suitable ways for achieving accurate results.
- Some candidates thought that when hydrochloric acid is added to aqueous ammonia, then ammonia gas is evolved and can be collected.

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- Many candidates tried to describe calculations in a vague manner despite the fact that the guidance said this was not required.
- Candidates who used an alternative method were generally unable to link this in any meaningful way to the conclusion required.