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

Other services from Cambridge International Education

- **Digital mocks service**
- **Insight assessments**
- **Professional development**
  - Focus on assessment
  - Online marking workshops

CHEMISTRY

Paper 0620/12
Multiple choice (Core)

Key messages

Candidates performed well on **Questions 1**, **2**, **3**, **4**, **6**, **7**, **12**, **13**, **14**, **16**, **18**, **21**, **22**, **24**, **26**, **27**, **28**, **29**, **30**, **32**, **35** and **38**.

Candidates performed less well on **Questions 5**, **8**, **9**, **10**, **11**, **15**, **17**, **19**, **20**, **23**, **25**, **31**, **33**, **34**, **36**, **37**, **39**, **40**.

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

Comments on specific questions

Question 5

- Option **A** was the most common incorrect answer.
- Option **A** gave the correct description of the number of electrons in a positive ion compared to an atom but did not give the correct name for a positive ion.

Question 8

- Option **B** was the most common incorrect answer.
- Core candidates are not expected to be able to define oxidation number but should be able to recognise the use of Roman numerals in a chemical name and to write correct formula for the products of precipitation reactions in qualitative tests. The formulas for copper(II) chloride and copper(II) hydroxide were incorrect option **B**.

Question 9

- Option **B** was the most common incorrect answer.
- Most candidates recalled that definitions of relative mass were compared to the carbon-12 isotope but linked it to the total mass, not the average mass of the isotopes.

Question 10

- Option **C** was the most common incorrect answer.
- Option **C** gives a substance used an as electrode, not an electrolyte.

Question 11

- Option **B** was the most common incorrect answer.
- Candidates chose the correct products but confused the electrodes at which these products would form.

Question 15

- Option **A** was the most common incorrect answer.
- Similarly to **Question 8**, candidates confused the significance of the (II) in the chemical name and assumed it gave the number of atoms rather than the oxidation number of the element.

Question 17

- Options **B** and **C** were the most common incorrect answers.
- In option **B**, candidates confused acidic and basic oxides. In option **C,** candidates confused the meaning of the term alkali.

Question 19

- Option **D** was the most common incorrect answer.
- In option **D**, candidates recalled that the density of Group I elements increases down the group but confused the trend in melting point.

Question 20

- Options **A** and **C** were the most common incorrect answers.
- Option **A** was partially correct in describing iodine as non-metallic, but it is not monatomic. In option **C,** candidates did not recall that the solid iodine is more dense than bromine.

Question 23

- Option **A** was the most common incorrect answer.
- In both reactions, 2 and 3 hydrogen is produced. This identifies substance **Y** as hydrogen, so substance **Z** cannot be hydrogen and must be the salt, magnesium sulfate.

Question 25

- Option **A** was the most common incorrect answer.
- Candidates confused the ease of extraction of a metal from its oxide and the reactivity of the metal. Metals which are easy to extract from their oxide are less reactive metals.

Question 31

- Option **A** was the most common incorrect answer.
- Option **A** is a correct statement but does not, on its own, explain why compounds in the same homologous series have the same reactivity.

Question 33

- Option **B** was the most common incorrect answer.
- The term ‘volatility’ was not well known, and option **B** was correct for the reverse order of substances.

Question 34

- Option **B** was the most common incorrect answer.
- Option **B** is the correct general formula for alkanes rather than alkenes.

Question 36

- Option **C** was the most common incorrect answer.
- Neither reaction chosen for option **C** would produce a gas.

Question 37

- Options **B** and **C** were the most common incorrect answers.
- In both options **B** and **C,** a correct statement about poly(ethene) was present, but for both options, candidates chose statement 3, confusing the terms monomer and polymer.

Question 39

- Option **B** was the most common incorrect answer.
- In option **B**, the dye labelled as '1' contained two colours present in the ink, but it also contained a colour not found in the ink sample and so could not be correct.

CHEMISTRY

Paper 0620/22
Multiple choice (Extended)

Key messages

Candidates performed well on **Questions 1**, **2**, **3**, **4**, **5**, **6**, **11**, **12**, **14**, **15**, **16**, **17**, **19**, **20**, **22**, **23**, **24**, **25**, **26**, **28**, **30**, **32**, **34**, **36**, **37** and **38**.

Candidates performed less well on **Questions 7**, **8**, **9**, **10**, **13**, **18**, **21**, **27**, **29**, **31**, **33**, **35**, **39** and **40**.

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

Comments on specific questions

Question 7

- Option **B** was the most common incorrect answer.
- Candidates used the information to correctly identify the two solids but did not link this deduction to the ions present and the lattice structures of metals and ionic compounds.

Question 8

- Option **B** was the most common incorrect answer.
- Candidates are reminded that the percentage yield describes the amount of desired product formed and is not calculated using the reacting mass.

Question 9

- Option **B** was the most common incorrect answer.
- In this reaction, an excess of zinc was used. Candidates choosing option **B** did not determine the moles of acid present and used the moles of zinc in their calculation.

Question 10

- Option **B** and **C** were the most common incorrect answers.
- For both of these options, candidates identified the correct movement of either the electrons or the positive ions but not both.

Question 13

- Option **A** was the most common incorrect answer.
- In option **A**, the correct method was chosen but candidates did not use two of the O–O bond enthalpies, and gave an answer which has a difference of 150 kJ / mol from the correct answer.

Question 18

- Option **C** was the most common incorrect answer.
- In option **C**, candidates identified H_2SO_4 as a proton donor but did not use the equations to identify which species were gaining or losing protons, H^+.

Question 21

- Options **A** was the most common incorrect answer.
- Candidates did not recall that insoluble salts are prepared by precipitation using two soluble salts.

Question 27

- Option **B** was the most common incorrect answer.
- Although harmful at elevated concentrations, CO_2 is an important gas present in clean air. The carbon, C, particulates and CO are both harmful atmospheric pollutants. Option **B** contained only one of these pollutants.

Question 29

- Options **A** was the most common incorrect answer.
- In option **A**, candidates identified the structural formula of the ester but did not reduce the formula to the simplest whole number ratio to give the empirical formula.

Question 31

- All the incorrect options were equally likely to be chosen.
- For all options, candidates did not recall the simple test-tube reaction using aqueous bromine to identify an unsaturated organic compound. No catalyst is required for this test.

Question 33

- Option **A** and **C** were the most common incorrect answers.
- In options **A** and **C**, the reactions of ethanoic acid, as a typical acid, with magnesium or with sodium hydroxide, were not well recalled. The by-products of each reaction were confused.

Question 35

- Option **B** was the most common incorrect answer.
- Candidates recalled that PET is a condensation polymer, but candidates who chose option **B** thought that this polyester was a polyamide or did not recall that PET can be converted back into monomers and re-polymerised.

Question 39

- Option **B** was the most common incorrect answer.
- Candidates correctly identified that the boiling point of water can be used to identify whether it is pure but, in this question, the impure sample could also be identified using a qualitative test. Option **B** omitted this simple chemical test for chloride ions.

Question 40

- Option **A** and **B** were the most common incorrect answers.
- In options **A** and **B**, candidates recalled that both calcium ions, Ca^{2+}, and aluminium ions, Al^{3+}, produce white precipitates when aqueous ammonia or aqueous sodium hydroxide is added. The further observations when excess alkali is added was not so well recalled.

CHEMISTRY

Paper 0620/32
Theory (Core)

Key messages

What candidates did well

- Many candidates demonstrated a solid grasp of key Chemistry concepts, such as:
  - Working out molecular formulas of organic compounds.
  - Balancing given symbol equations.
  - Working out the numbers of particles in a given atom.
  - Stating the meaning of state symbols.
- Most candidates were able to work out the relative formula mass of a given compound and were able to give the pH value of an alkali.
- Some candidates were able to state why fertilisers are used, and outlined the physical properties of an ionic compound.

What candidates needed to improve

- Many candidates did not know the chemical tests and could not recall the chemical test for potassium ions and iodide ions.
- Most candidates did not know the common problems with air pollutants such as nitrogen dioxide, and water pollutants such as phosphates and metal compounds.
- Misreading questions led to errors, such as describing the arrangement and separation of the particles in a gas. Some candidates thought that the separation used here was a separation technique that is used to separate mixtures, not how the particles are separated in the gaseous state.

Comments on specific questions

Question 1

(a) **Comprehensive responses**

- Most candidates knew that nitrogen is approximately 78 percent of clean, dry air.

(b) **Comprehensive responses**

- Many candidates knew that hydrogen gas is formed when a metal reacts with an acid.

Limited responses

- Some candidates did use other elements from the table including chlorine and oxygen.

(c) **Comprehensive responses**

- Many candidates could state that aluminium or boron forms an ion with a $^{3+}$ charge.

Limited responses

- Some candidates did not use the Periodic Table. The charge on the ion is $^{3+}$ so it would be from Group III.

(d) **Comprehensive responses**

- Most candidates knew that the correct answer was sodium.

Limited responses

- Some candidates did not add up the number of electrons given, and then, did not use the Periodic Table to look up the correct element.

(e) **Comprehensive responses**

- Many candidates knew which element was the most reactive.

Limited responses

- A few candidates did not know the reactivity series of metals and so could not give the correct answer.

(f) **Comprehensive responses**

- Some candidates knew what a monatomic gas was and could choose helium.

Limited responses

- Many candidates did not know what a monatomic gas was and so could not choose a noble gas out of the given list.

(g) **Comprehensive responses**

- Most candidates knew a product of photosynthesis.

(h) **Comprehensive responses**

- Most candidates knew that zinc is found in brass.

(i) **Comprehensive responses**

- Many candidates knew that oxygen is a gas needed for iron to rust.

Question 2

(a) (i) **Comprehensive responses**

- Most candidates knew the general formula.

Limited responses

- Some candidates confused the organic group asked. For example, they gave the general formula for an alkene.

(ii) **Comprehensive responses**

- Many candidates knew that carbon dioxide and water are the two substances produced during complete combustion.

Limited responses

- A few candidates confused complete combustion with incomplete combustion and gave incorrect products. For example, carbon monoxide or carbon.

(b) (i) **Comprehensive responses**

- Many candidates were able to draw a circle around the ‘OH’ group.

Limited responses

- Some candidates included the carbon next to the ‘OH’ group.
- A few candidates confused the carbon-carbon double bond with the alcohol functional group.

(ii) **Comprehensive responses**

- Most candidates could deduce the molecular formula of the given compound.

Limited responses

- Some candidates put ‘+’ between the elements which is not allowed in a molecular formula.
- A few candidates used superscripts to show the numbers of atoms instead of subscripts.

(iii) **Comprehensive responses**

- Most candidates knew at least one of the colours for this chemical test.

Limited responses

- Some candidates got confused with the correct colour change and put the colours the other way around.
- A few candidates used colour changes that were for different reactions.

(c) (i) Comprehensive responses

- A few candidates recalled both the conditions for the fermentation of aqueous glucose, including the correct temperature needed.

Limited responses

- Some candidates knew one condition and then stated 'catalyst' for the second condition which was not in enough detail.
- Many candidates confused this process with the process of making ethanol using steam, and used the conditions for that process instead.

(ii) Comprehensive responses

- Most candidates could answer with the separation technique of fractional distillation or filtration.

Limited responses

- Some used the term evaporation or boiling instead of a correct separation technique.

(d) (i) Comprehensive responses

- Many candidates knew the correct homologous series.

Limited responses

- Some candidates got confused with the word 'homologous series' and named other carboxylic acids.

(ii) Comprehensive responses

- Some candidates knew both the correct products of this equation.
- Many candidates could work out one product only.

Limited responses

- Many candidates gave one product as water instead of hydrogen.
- Some candidates did not know the correct spelling for the ethanoate ion.

(e) Comprehensive responses

- A few candidates could correctly show the displayed formula of the monomer.

Limited responses

- Many candidates wrote other monomers down such as propene.
- Some candidates gave the formula of the repeating unit instead of the ethene monomer.

Question 3

(a) (i) Comprehensive responses

- Many candidates knew the correct period for titanium using the Periodic Table.

Limited responses

- Some candidates confused the period and mainly thought that titanium was in period 3. They had forgotten that hydrogen and helium are in period 1.

(ii) Comprehensive responses

- Most candidates could work out the number of neutrons and protons in the isotope of titanium.

Limited responses

- A few candidates confused the number of neutrons and thought that they were the mass number of 50.

(b) Comprehensive responses

- Most candidates could state at least one property of a transition element such as high melting point or high density.

Limited responses
- A few candidates were confused with the properties and used low melting point and low density.

(c) Comprehensive responses
- Most candidates could balance the given equation.

Limited responses
- Some candidates put a 4 in front of the magnesium chloride and got confused with the 2 chlorines that were already in the compound.

(d)(i) Comprehensive responses
- A few candidates were able to define the term electrolysis using the two main points in the definition.
- Some candidates were able to write down one of the points in this definition.

Limited responses
- Many of the candidates did not use the terms 'ionic' and either 'electricity' or 'electric current' in their definition.

(ii) Comprehensive responses
- Most candidates did know a property of graphite in the context of using it as an electrode.

Limited responses
- A few candidates did not know a property in the context of using it as an electrode. 'Inert' or 'conducts electricity' were two properties.

(iii) Comprehensive responses
- Many candidates knew a use for graphite.

Limited responses
- A few candidates left this response blank. Lubricant is a good use.

(iv) Due to an issue with question **3(d)(iv)**, full marks have been awarded to all candidates for this question to make sure that no candidates were disadvantaged.

(v) Comprehensive responses
- Many candidates could give the correct products at the correct electrodes.
- Some candidates could also suggest the observations at the positive electrode.

Limited responses
- Some candidates confused where each product should form and put them to the other electrodes.
- A few candidates used 'chloride' instead of 'chlorine' in their answers.
- Many candidates did not know the correct observations and would benefit from doing different examples of the same question.

Question 4

(a)(i) Comprehensive responses
- Many candidates understood the state symbol and knew that it meant aqueous or dissolved in water.

Limited responses
- Some candidates confused the meaning and thought that it meant presence of water.

(ii) Comprehensive responses
- Most candidates were able to name the correct item of apparatus.

Limited responses

- Some candidates thought that a measuring cylinder could be used but did not know that it must be over water.

(b) (i) Comprehensive responses

- Some candidates could put the experimental concentrations in the correct order in the context of this experiment.

Limited responses

- Many candidates confused the order and would benefit from practising very similar types of questions to this one.

(ii) Comprehensive responses

- Some candidates could answer this question in terms of how the time taken changed.

Limited responses

- Many candidates confused time taken with rate in this question.

(c) Comprehensive responses

- Some candidates were able to define the term catalyst using the two main points in the definition.
- Many candidates were able to write down one of the points.

Limited responses

- Some candidates were confused with the definition and would benefit with more practice of definitions.

(d) (i) Comprehensive responses

- A few candidates did know the colour change of the methyl orange indicator.

Limited responses

- Some candidates confused the colours and got them the other way around.
- Many candidates did not know the correct colours and would benefit with more practice of the different colours of indicators in acids and alkalis.

(ii) Comprehensive responses

- Some candidates knew the correct formula of the ion.

Limited responses

- Many candidates confused the formula and also gave equations.

(iii) Comprehensive responses

- Most candidates could circle the correct value for the pH of an alkali.

(e) Comprehensive responses

- Most candidates could name this separation technique.

(f) Comprehensive responses

- Some candidates understood which oxides are acidic and which are basic.

Limited responses

- Some candidates confused the oxides and got them the other way around and would benefit from more practice of this type of question.

Question 5

(a) (i) Comprehensive responses

- Most candidates knew that the other element was potassium.

Limited responses

- A few candidates thought that the symbol K in NPK fertilisers was Krypton.

(ii) Comprehensive responses

- Most candidates knew why fertilisers were used. Examples of good answers were ‘to make crops grow faster’, ‘increase growth of plant’ and ‘increase yield of crops’.

Limited responses

- Some candidates confused this answer and used to ‘kill pests’, ‘kill bacteria’ and ‘to provide more nutrients’.

(iii) Comprehensive responses

- Some candidates did know the name of the compound from its given ions.

Limited responses

- Many candidates did not know the name of this compound and would benefit from more examples of naming compounds when the ions it contains are given.

(iv) Comprehensive responses

- Most candidates understood how to calculate the relative formula mass of the given compound and used the correct number of atoms to do it.

Limited responses

- A few candidates did not use the correct number of atoms given in the formula and would benefit from more examples of this type of calculation.

(b) Comprehensive responses

- A few candidates knew the correct reasons for why the given substances were harmful in river water. ‘Phosphates in the deoxygenation of water’ and ‘metal compounds being toxic or poisonous’ were good answers.

Limited responses

- A few candidates knew one correct reason only.
- Many candidates did not know any correct reasons. ‘Kills marine life’ and ‘causing rusting for metal compounds’ were common incorrect answers for phosphates.

(c) (i) Comprehensive responses

- Many candidates could write the correct word equation from the information given.

Limited responses

- Some candidates wrote the formula equation instead of the word equation.

(ii) Comprehensive responses

- Most candidates knew at least one adverse effect of nitrogen dioxide in air.

Limited responses

- Some candidates were not specific enough and wrote down health issues.
- A few candidates also confused this air pollutant with causing climate change or being a greenhouse gas.

Question 6

(a) (i) Comprehensive responses

- Many candidates were able to give two correct properties of aluminium in the context of it being used in the manufacturing of overhead power cables.

Limited responses

- A few candidates confused the properties and answered with ‘high density’ and ‘does not conduct electricity’.

(ii) Comprehensive responses

- Most candidates knew that diamond is hard and so it is suitable for use in cutting tools.

(b) Comprehensive responses

- Some candidates were able to state the correct physical state of X at the given temperature and then went on to explain why using its given melting and boiling point.

Limited responses

- Some candidates could state the correct physical state. They got confused with the explanation and would benefit from more practice of this type of question.

Question 7

(a) (i) Comprehensive responses

- Most candidates were able to state the correct definition of isotopes using protons and neutrons.

Limited responses

- Some candidates confused the particles and got them the other way around. For example, same number of neutrons and different number of protons.

(ii) Comprehensive responses

- A few candidates could recognise the specific isotope.

Limited responses

- Many candidates confused recognising the correct isotope. Candidates used all the other responses and sometimes they circled two responses.

(b) Comprehensive responses

- A few candidates knew both the arrangement and separation of the particles in the context of gaseous oxygen.

Limited responses

- A few candidates confused the arrangement and separation of a gas with other states of matter.
- Some candidates confused the arrangement of the particles in the gas with the separation of them.
- A few candidates thought that this question was asking for separation techniques and so stated distillation as answer for the separation part.

(c) Comprehensive responses

- Most candidates knew the correct change of state for the given description.

Question 8

(a) Comprehensive responses

- Very few candidates knew the correct chemical tests for the given ions.

Limited responses

- Some candidates knew that a flame test was needed to test for potassium ions. They got confused with the correct colour of the flame and used colours of other cations instead.
- A few candidates knew the test for iodide ions and again got confused with the correct colour of the silver iodide precipitate made in this reaction.
- Candidates would benefit from practicing similar style questions.

(b) Comprehensive responses

- Some candidates did identify the correct water soluble compound from the given list.

Limited responses

- Some candidates confused the solubility rules and would benefit from applying these rules to different examples.

(c) Comprehensive responses

- A few candidates were able to state the two properties which included ‘high melting and boiling points’ and ‘conducts electricity when molten’.

Limited responses

- Most candidates knew that ionic compounds conduct electricity. They did not state that this occurs only when the compounds are molten or in aqueous solution.

(d) **Comprehensive responses**

- Many candidates knew the correct answer to this calculation question.

Limited responses

- Some candidates confused the ratios in this question and would benefit from more practice on this type of question.

CHEMISTRY

Paper 0620/42
Theory (Extended)

Key messages

What candidates did well
- Most candidates showed a good knowledge of the contents of all areas of the syllabus.
- Most candidates showed full working in calculations.
- Most candidates wrote short concise answers.

What candidates needed to improve
- Some candidates should realise that if the question asks for one answer, then two (or more) answers should not be given.
- Some candidates did not apply subscript and occasionally superscript correctly when writing formulae.
- Some candidates wrote irrelevant comprehensive sentences such as in **Question 1(a)**. For example, 'The catalyst used in the Haber process is Fe' when all that was required was 'Fe'.

Comments on specific questions

Section A

Question 1

(a) **Comprehensive responses**
- Most candidates correctly identified Fe.

Limited responses
- Some candidates wrote V.

(b) **Comprehensive responses**
- Nearly all candidates correctly identified Zn.

Limited responses
- Some candidates wrote Cr.

(c) **Comprehensive responses**
- Most candidates correctly identified Co.

Limited responses
- Some candidates wrote Cu.

(d) **Comprehensive responses**
- Most candidates correctly identified Ni.

Limited responses
- Some candidates wrote Fe or Mn.

(e) **Comprehensive responses**
- Some candidates correctly identified Cr.

Limited responses
- Most candidates wrote Fe.

(f) **Comprehensive responses**

- Most candidates correctly identified Co.

Limited responses

- Some candidates wrote Cr.

(g) **Comprehensive responses**

- Nearly all candidates correctly identified Zn.

Limited responses

- Some candidates wrote Ni or Fe.

Question 2

(a) (i) **Comprehensive responses**

- Most candidates knew the main ore of aluminium.

Limited responses

- Some candidates wrote hematite or bauxide.

(ii) **Comprehensive responses**

- Nearly all candidates correctly knew electrolysis.

Limited responses

- Some candidates identified industrial processes, such as cracking.

(iii) **Comprehensive responses**

- Most candidates knew that cryolite was added to aluminium oxide.

Limited responses

- Some candidates identified substances used in the extraction of iron rather than the extraction of aluminium.

(b) (i) **Comprehensive responses**

- Most candidates identified amphoteric oxides.

Limited responses

- Some candidates confused the terms neutral and amphoteric.

(ii) **Comprehensive responses**

- Most candidates were able to correctly name aluminium chloride as the product.

Limited responses

- Some candidates knew the formula of aluminium chloride.

(c) (i) **Comprehensive responses**

- Most candidates were able to complete the equation.

Limited responses

- Some candidates did not balance the equation.

(ii) **Comprehensive responses**

- Some candidates deduced the formula of the anion as that of aluminate.

Limited responses

- Many candidates thought I was the formula of the oxide ion.

(d) (i) **Comprehensive responses**

- Most candidates identified 5.

Limited responses
- Some candidates attempted to write the full electron configuration.

(ii) Comprehensive responses
- Most candidates correctly filled in **Table 2.1**.

Limited responses
- Some candidates confused the number of neutrons with the mass number.

(iii) Comprehensive responses
- Most candidates knew to multiply mass x abundance.

Limited responses
- Some candidates divided their mass x abundance totals by 100 instead of 20.

Question 3

(a) (i) Comprehensive responses
- Most candidates knew the correct flame colour.

Limited responses
- Some candidates gave colours other than yellow.

(ii) Comprehensive responses
- Most candidates knew the colour of chlorine.

Limited responses
- Some candidates gave the colour of another halogen.

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(iii) Comprehensive responses
- Some candidates were able to determine the moles of Cl_2 by using the molar gas volume and then use the stoichiometric relationship to determine the moles of NaCl and its mass.

Limited responses
- Some candidates did not use the molar gas volume. Some candidates assumed the M_r of NaCl was 117. Some candidates assumed the stoichiometric ration was 1 : 1.

(b) (i) Comprehensive responses
- Most candidates knew the correct ionic equation.

Limited responses
- Some candidates included spectator ions.

(ii) Comprehensive responses
- Most candidates named a suitable indicator.

Limited responses
- Some candidates named universal indicator.

(iii) Comprehensive responses
- Most candidates knew the technique used in Method 2.

Limited responses
- Some candidates thought the method was neutralisation.

(c) Comprehensive responses
- Most candidates correctly completed the dot and diagram.

Limited responses
- Some candidates showed the electron gained by chlorine from sodium as a ● rather than as a **x** or gave the electron configuration of atoms.

(d) (i) Comprehensive responses

- Most candidates could name both inert electrodes.

Limited responses

- Some candidates assumed copper to an inert metal electrode.

(ii) Comprehensive responses

- Most candidates named product at the cathode for all three forms of NaCl.

Limited responses

- Some candidates named the ions that migrated to the cathode or named products formed at the anode.

Question 4

(a) Comprehensive responses

- Most candidates knew that the bidirectional arrow showed the reaction was reversible and a negative ΔH value showed the reaction was exothermic.

Limited responses

- Some candidates referred to the reversible symbol without saying what that symbol was.

(b) Comprehensive responses

- Most candidates correctly stated the effect of temperature decrease and catalyst removal on the rate of the reaction and some candidates were able to predict correctly the effect of the changes on concentration of methanol.

Limited responses

- Some candidates thought that the effect on the rate would be the same as the effect on the concentration of methanol.

(c) (i) Comprehensive responses

- Some candidates produced carefully labelled reaction pathway diagrams.

Limited responses

- Some candidates used a double headed arrow for the enthalpy change and some candidates drew arrows that were too short or too long.

(ii) Comprehensive responses

- Many candidates knew that the enthalpy change of the reverse reaction would be the positive value of the forward reaction.

Limited responses

- Some candidates did not include a sign for each answer and a most assumed the reverse activation would be the negative value of the forward activation energy.

(d) Comprehensive responses

- Most candidates were able to calculate the energy needed to break the bonds in the reactants.
- Many candidates were able to calculate the energy released when the bonds in water form.
- Some candidates were able to use these two calculated figures to determine the bond energy of the C–H bond.
- Some candidates who arrived at the correct answer did not work through the calculation steps requested while showing a clear and logical approach.

Limited responses

- Some candidates made progress with the first two bullet pointed steps and then did not fully understand how the bond energy required could be calculated.
- Some candidates calculated a negative energy value in the last part which would lead to a negative bond energy value.

(e) **Comprehensive responses**

- Most candidates produced dot and cross diagrams that fully complied with the conventions used when drawing such diagrams.

Limited responses

- Some candidates used two dots to represent the O–H bond.
- Some candidates drew the C–O as being double.
- Another common error was the omission of all the non-bonding electrons from the oxygen atom.
- Some candidates used crosses rather than dots to represent the oxygen non-bonding electrons as they did not notice that the inner electrons pre-drawn for oxygen were dots.

(f) **Comprehensive responses**

- Most candidates completed and balanced the equation.

Limited responses

- A few candidates gave an incorrect reactant.

Question 5

(a) **Comprehensive responses**

- Most candidates knew the term homologous series.

Limited responses

- Some candidates wrote group rather than series or used the term hydrocarbon.

(b) **Comprehensive responses**

- Most candidates correctly linked chemical properties to the same functional group.

Limited responses

- Some candidates added in extra features which do not determine chemical properties.

(c) **Comprehensive responses**

- Most candidates knew the general formula.

Limited responses

- Some candidates did not use correct subscripts and others wrote RCOOH.

(d) **Comprehensive responses**

- Many candidates knew the name of **A**.
- Some candidates wrote the structural formula of **B**.
- Some candidates wrote the molecular formula of **C**.
- A few candidates wrote the empirical formula of **D**.

Limited responses

- Some candidates omitted the name of **A**.
- Some candidates gave an ambiguous structural formula attempt for **B**, for example $CH_3C{=}OOH$ or CH_3CHO_2.
- Some candidates drew a displayed formula.
- Many candidates gave the molecular formula.

(e) (i) **Comprehensive responses**

- Few candidates knew that knew the correct IUPAC name propan-1-ol.

Limited responses

- Most candidates named the alcohol as propanol.

(ii) **Comprehensive responses**

- Some candidates correctly named the oxidising agent.

Limited responses
- Some candidates gave the incorrect Roman numeral and some candidates assumed manganate was manganese oxide.

(iii) Comprehensive responses
- Very few candidates knew the two conditions given in the syllabus.

Limited responses
- Most candidates gave pressures and temperatures associated with organic processes.

(f) (i) Comprehensive responses
- Most candidates knew the identity of the catalyst.

Limited responses
- Some candidates gave the identity of catalysts used in other reactions.

(ii) Comprehensive responses
- Most candidates were able to name both products.

Limited responses
- Some candidates omitted water as a product or spread the two names of the ester over both answer lines.

(iii) Comprehensive responses
- Some candidates correctly drew the displayed formula.

Limited responses
- Some candidates drew incorrect ester linkages, omitted hydrogens and/or added carbons to the alkyl group.

Question 6

(a) Comprehensive responses
- Some candidates deduced two amino acid monomers were needed.

Limited responses
- Most candidates assumed three amino acid monomers were needed.

(b) Comprehensive responses
- Few candidates deduced three water molecules were produced.

Limited responses
- Few candidates deduced three water molecules were produced.

(c) Comprehensive responses
- Most candidates knew there was a hydrogen atom bonded to the carbon atom and a few drew the correct functional groups.

Limited responses
- Most candidates did not draw displayed formulae of the functional groups.

(d) (i) Comprehensive responses
- Most candidates correctly deduced two repeat units were shown.

Limited responses
- Some candidates thought there were 3 or 4 repeat units.

(ii) Comprehensive responses
- Some candidates correctly named dicarboxylic acids and diamines.

Limited responses

- Many candidates named the types of organic compounds as carboxylic acids and amines, or included diols.

CHEMISTRY

Paper 0620/52
Practical Test

Key messages

Demonstrate knowledge of how to select and safely use techniques, apparatus and materials (including following a sequence of instructions where appropriate)

What candidates did well
- Most candidates were able to complete all 5 experiments in the quantitative practical.
- Many candidates obtained results in the quantitative practical that were similar to those expected.

What candidates needed to improve
- Candidates should look carefully at the first colour of the flame seen when conducting a flame test.
- Candidates should carefully check the instructions in practical tasks to ensure the order of addition of the reagents is correct and that the correct reagents are used.

Plan experiments and investigations

What candidates did well
- Most candidates planned an experiment that would produce a sample of the hydrated salt required.

What candidates needed to improve
- Candidates should plan out their answers to avoid the need for notes at the end of the experimental plan that modify it.
- Candidates should avoid writing lists of apparatus, this takes time and does not form part of an experimental plan.

Make and record observations, measurements and estimates

What candidates did well

- Most candidates were able to record appropriate readings as instructed in the quantitative task.
- Most candidates were able to make appropriate observations in the qualitative task.

What candidates needed to improve
- Attention should be given to the number of decimal places used when recording quantitative data.
- Candidates need to ensure when two reagents are combined in a qualitative test that the two reagents are mixed together and do not form separate layers.

Interpret and evaluate experimental observations and data

What candidates did well
- Most candidates made good use of the “notes for use in qualitative analysis” printed at the back of the examination paper.

What candidates needed to improve
- When drawing a best-fit line to show experimental observations, candidates need to consider if a curve or straight line is the most appropriate option for their data.

Evaluate methods and suggest possible improvements

What candidates needed to improve

- Candidates needed to consider the consequences of their suggested changes to apparatus and how they will actually improve the experiment.

Comments on specific questions

Question 1

(a) Comprehensive responses

- Most candidates recorded results for all five experiments.
- Most candidates obtained results that followed the expected pattern of taking less time as the volume of water decreased.

Limited responses

- Some candidates recorded times to one decimal place or more.
- Some candidates obtained results that did not follow the expected pattern.
- Some candidates did not obtain a time for Experiment 1 that was similar to the supervisor's result.

(b) Comprehensive responses

- Most candidates used a sensible scale for the *y*-axis.
- Most candidates plotted the data from the table accurately using a small cross to represent each datum point.

Limited responses

- Graph scales should be selected so that the plotted data takes up over half of the available graph grid to be used in both directions.
- Some candidates selected awkward graph scales, the section 'Presentation of Data – Graphs' in the syllabus gives advice on graph scales.
- A few candidates used multiple attempts to draw graph lines, straight line sections or dot to dot best-fit lines.

(c) (i) Comprehensive responses

- Most candidates carried out the calculation correctly.
- Most candidates stated appropriate units for the rate of the reaction.

Limited responses

- Some candidates used a volume of gas of 45 cm^3 (the volume of the water added) rather than 50 cm^3.
- A few candidates rounded their answer incorrectly.
- A few candidates used the wrong time or an average of experimental times.

(ii) Comprehensive responses

- Most candidates showed appropriate working on their graph in the form of lines from/to both axes and read the value from their working correctly.

Limited responses

- Some candidates omitted to show the working on their graph.
- Some candidates took readings from an incorrect volume of water.

(d) Comprehensive responses

- A few candidates were able to appreciate that any carbon dioxide produced would push air out of the flask and into the measuring cylinder and that this would mean the volume of gas collected is the same as the volume of carbon dioxide produced and so there would be no change in accuracy.

Limited responses

- Many candidates incorrectly thought that the air in the apparatus would increase the volume of gas collected and so make the results inaccurate.

(e) (i) Comprehensive responses

- Some candidates understood that the acid and the sodium hydrogencarbonate needed to be kept apart in some way so that they could not react until the apparatus was sealed.

Limited responses

- Some candidates suggested putting the sodium hydrogencarbonate in a container suspended on a thread within the conical flask stated that the thread could be cut or pulled to release the container into the acid. This will not work as the bung will hold the thread in place.
- Some candidates suggested adding a new opening to the conical flask which would simply result in the need to remove a different stopper and so create a gas leak.
- Many candidates suggested collecting the gas in a gas syringe, this will not remove the need to take the stopper out of the flask and so will not prevent some of the gas leaking.

(ii) Comprehensive responses

- Some candidates appreciated that if some gas escapes then less will be collected and so the collection of 50 cm^3 would take a longer time.

Limited responses

- Some candidates gave answers in terms of the accuracy of the results rather that in terms of the time taken as asked in the question.

(f) Comprehensive responses

- Some candidates realised that 50 °C is higher than room temperature and so the reaction would be faster, meaning that the time taken would be lower than at room temperature for all concentrations of the acid. They drew lines correctly on the graph to show this.

Limited responses

- Some candidates drew lines that showed the reaction would be slower at a higher temperature.
- Some candidates drew lines that indicated that the time taken would drop to zero seconds.
- Some candidates drew lines which showed that, at some volumes of water, the time for the collection of gas would be the same at the higher temperature and room temperature.

Question 2

(a) Comprehensive responses

- Most candidates noted that the solid became black as a result of heating.
- Some candidates noticed the formation of condensation on the walls of the boiling tube.

Limited responses

- A few candidates referred to the colour changing without being specific as to the final colour.
- Many candidates did not notice the formation of condensation.

(b) Comprehensive responses

- Some candidates gave a correct observation and a correct gas test.

Limited responses

- A few candidates gave incorrect positive gas tests for hydrogen, oxygen, or chlorine.
- Some candidates did not observe any effervescence.
- A few candidates gave white precipitate as an observation without reference to limewater.

(c) (i) Comprehensive responses

- Most candidates gave the expected observations for copper(II) ions reacting with aqueous sodium hydroxide.

Limited responses

- Some candidates may have accidently used aqueous ammonia instead of aqueous sodium hydroxide as they reported the formation of a dark blue solution.
- A few candidates gave the wrong colour of precipitate such as white or green.

(ii) **Comprehensive responses**

- Some candidates reported that no reaction occurred.

Limited responses

- Some candidates reported the formation of a green or white precipitate.
- Some candidates reported effervescence, this was probably a result of not leaving the solid behind when separating the solution from the excess solid copper(II) carbonate as instructed at the start of **2(c)**.

(iii) **Comprehensive responses**

- A few candidates gave fully correct observations.

Limited responses

- Most candidates gave observations which suggested that they had added ammonia dropwise and then in excess to solution **C** rather than following the instructions and adding solution **C** dropwise and then in excess to aqueous ammonia.

(d) **Comprehensive responses**

- Most candidates correctly identified both the anion and the cation as solid **A**.

Limited responses

- Some candidates identified only the anion or the cation as solid **A**.

(e) **Comprehensive responses**

- Many candidates gave the correct flame test colour for the barium compound used.

Limited responses

- Some candidates stated that the flame colour was orange rather than state the colour first seen when the sample is put into the flame.
- A few candidates gave observations that did not relate to a flame test. For example, fizzing.

(f) (i) **Comprehensive responses**

- Most candidates gave the expected observation.

Limited responses

- A few candidates stated there was a white solid or a white solution rather than refer to a precipitate.
- A few candidates reported seeing effervescence.

(ii) **Comprehensive responses**

- Most candidates gave the expected observation.

Limited responses

- Some candidates reported a cream colour in place of white.
- A few candidates stated there was a white solid or a white solution rather than refer to a precipitate.

(g) **Comprehensive responses**

- Some candidates correctly identified both the anion and the cation in solution **B**.

Limited responses

- A Some candidates identified solution **B** as a sodium salt, even though this would not explain the white precipitate seen in **2(f)(i)**.

Question 3

Comprehensive responses

- Many candidates outlined a suitable method for producing crystals of hydrated chromium(III) nitrate.
- Some candidates planned out their answers so that they wrote the plan in steps and all steps were in a logical sequence and included details, such as the apparatus required.

Limited responses

- Some candidates spent time at the start of their plans trying to identify dependent, independent and control variables; as this is a qualitative preparation task, there are no variables.
- Some candidates produced a list of apparatus rather than include it within the plan and state what the apparatus was to be used for.
- Some candidates suggested inappropriate glassware. For example, burettes for measuring the volume of a solid.
- Some candidates stated they were starting with chromium nitrate and so did not describe how to make chromium(III) nitrate.
- Many candidates did not appreciate that the chromium(III) oxide should be added in excess and instead specified that the nitric acid should be in excess.
- Many candidates did not appreciate that, because the reaction was very slow, it should be heated to increase the rate of the reaction.
- Some candidates tried to produce a solution of chromium(III) oxide at the start of the procedure.
- Some candidates described the inappropriate method of carrying out a titration.
- The need to filter the excess chromium(III) oxide from the reaction mixture prior to crystallisation was not always appreciated.
- Some candidates heated the chromium(III) nitrate to dryness and so obtained anhydrous chromium(III) nitrate which they then tried to rehydrate.

CHEMISTRY

Paper 0620/62
Alternative to Practical

Key messages

What candidates did well
- Most candidates gave readings to an appropriate number of decimal places.
- Most candidates were able to devise an appropriate scale for graph work and to plot data correctly.
- Most candidates could use the Notes for use in Qualitative Analysis to give appropriate observations.

What candidates needed to improve
- Some candidates need to ensure they use graph scales that follow the recommendations in the Presentation of Data – Graphs section of the syllabus. Graph scales should be selected so that the plotted points take up over half the available graph grid in both directions.
- Some candidates, when drawing best fit lines, need to consider if a curve or a straight line is better for the data.
- Some candidates need to avoid listing dependent, independent and control variables unless they are specifically asked for in a question.
- When candidates are evaluating or suggesting improvements to experimental methods they need to think through their suggestions to ensure they do address the question asked.

Comments on specific questions

Question 1

(a) (i) Comprehensive responses
- Most candidates were able to identify the apparatus labelled **A** on diagram.

Limited responses
- A few candidates used vague terms such as ‘tub’ or incorrect names such as ‘flask’ or ‘measuring cylinder’.

(ii) Comprehensive responses
- Most candidates could name an appropriate metal for the anode.

Limited responses
- Some candidates named materials that would not replace the silver ions removed from the solution during electrolysis, giving answers such as graphite, platinum or zinc.

(iii) Comprehensive responses
- Most candidates realised the electrolyte had to contain silver ions and could name an appropriate silver salt to use.

Limited responses
- Few candidates realised that the electrolyte needed have mobile silver ions and so be able to conduct electricity. These candidates omitted to state that the electrolyte should be aqueous or molten.

(b) (i) Comprehensive responses
- Used the appropriate gas test to show that chlorine gas comes out of the side arm.

Limited responses

- Some candidates explained why chlorine gas comes out of the side arm rather than out of anywhere else rather than use a test to identify the gas.
- Some candidates described collecting the gas, often in a gas syringe, rather than testing the gas.

(ii) Comprehensive responses

- Some candidates correctly stated a safety precaution linked to the toxic nature of chlorine gas.

Limited responses

- Some candidates, although realising that chlorine is toxic, gave safety precautions that were not appropriate, such as the use of a mask (which would not protect the wearer from the toxic gas) or a gas mask (which is not normal laboratory safety equipment).
- Some candidates gave generic safety precautions, such as wearing goggles, rather than a precaution specific to the formation of chlorine gas.

Question 2

(a) Comprehensive responses

- Most candidates correctly used the information in the descriptions of the experiments and the stop watch diagrams to complete the table.

Limited responses

- A few candidates recorded times to a greater precision than the nearest second.
- A few candidates did not convert the time into seconds only, instead using minutes and seconds.
- A few candidates did not realise there are 60 seconds in a minute.

(b) Comprehensive responses

- Most candidates chose the expected graph scale of each large grid square being equivalent to 50 seconds.
- Most candidates plotted the data correctly within half a small square tolerance.
- Some candidates drew a smooth curve through their data points.

Limited responses

- A few candidates chose difficult scales such as each large square being 41 or 42 seconds.
- A few candidates selected a y-axis scale that stopped at 200 seconds despite there being a point at 205 seconds.
- Some candidates plotted points incorrectly, this was far more common where a difficult scale had been selected.
- Some candidates drew a straight line of best fit despite the points lying on a curve.

(c) (i) Comprehensive responses

- Most candidates carried out the division correctly and rounded their final answer correctly.
- Most candidates could state the correct units for the rate.

Limited responses

- Some candidates used a time that was not the time recorded for Experiment **3**.
- A few candidates used 45 cm^3 (the volume water added) rather than 50 cm^3 as the numerator in the calculation.
- Some candidates rounded their answer incorrectly, the most common being to give the answer as 0.69 or 0.684.

(ii) Comprehensive responses

- Most candidates showed appropriate working on their graph in the form of lines from/to both axes and read the value from their working correctly.

Limited responses

- Some candidates omitted to show the working on their graph.
- Some candidates took readings from an incorrect volume of water.

(d) **Comprehensive responses**

- A few candidates were able to appreciate that any carbon dioxide produced would push air out of the flask and into the measuring cylinder. This would mean the volume of gas collected is the same as the volume of carbon dioxide produced, so there would be no change in accuracy.

Limited responses

- Many candidates incorrectly thought that the air in the apparatus would increase the volume of gas collected, which makes the results inaccurate.

(e) (i) **Comprehensive responses**

- Some candidates understood that the acid and the sodium hydrogencarbonate needed to be kept apart in some way so that they could not react until the apparatus was sealed. This was achieved by either using a divided flask or by placing the solid reagent in a tube inside the flask; in both cases the reaction can be started by tilting the flask.

Limited responses

- Some candidates who put the sodium hydrogencarbonate in a container suspended on a thread within the conical flask stated that the thread could be cut or pulled to release the container into the acid. This will not work as the bung will hold the thread in place.
- Some candidates suggested adding a new opening to the conical flask which would simply result in the need to remove a different stopper and create a gas leak.
- Many candidates suggested collecting the gas in a gas syringe. This will not remove the need to take the stopper out of the flask and will not prevent some of the gas leaking.

(ii) **Comprehensive responses**

- Some candidates appreciated that if gas escapes, then less will be collected. The collection of 50 cm^3 would take a longer time.

Limited responses

- Some candidates gave answers in terms of the accuracy of the results or the volume of gas collected rather that in terms of the time as asked in the question.

(f) **Comprehensive responses**

- Some candidates realised that 50 °C was higher than room temperature and so the reaction would be faster, meaning that the time taken would be lower than at room temperature for all concentrations of the acid.

Limited responses

- Some candidates drew lines that showed the reaction would be slower at a higher temperature.
- Some candidates drew lines that indicated that the time taken would drop to zero seconds.
- Some candidates drew lines which showed that, at some volumes of water, the time for the collection of gas at the higher temperature and room temperature would be the same.

Question 3

(a) **Comprehensive responses**

- Most candidates could correctly identify the gas produced.

Limited responses

- A few candidates identified an incorrect gas.
- A few candidates gave the name of the anion in compound **A** rather than the identity of the gas produced.

(b) (i) **Comprehensive responses**

- Some candidates correctly interpreted the negative result from this anion test.

Limited responses

- A few candidates gave the expected result of a positive sulfate test.
- A few candidates concluded that solid **A** did contain sulfate ions despite the negative test result.

- A few candidates concluded that solid **A** did not contain an anion.

(c) **Comprehensive responses**

- Most candidates gave the correct identity of solid **A**.

Limited responses

- Some candidates identified only one of the ions in solid **A**.

(d) **Comprehensive responses**

- Most candidates gave the correct result of adding excess aqueous ammonia to solution **C**. There was no need to give the result of dropwise addition, and the initial formation of a light blue precipitate was ignored.

Limited responses

- A few candidates stated that a precipitate would form and then contradicted the idea of a solution forming by stating the precipitate was insoluble.

(e) (i) **Comprehensive responses**

- Most candidates knew the type of flame required.

Limited responses

- A few candidates gave contradictory answers, such as ‘blue luminous flame’
- A few candidates stated that a Bunsen flame or a spirit burner flame should be used; neither of these are types of Bunsen burner flames.

(ii) **Comprehensive responses**

- Most candidates could correctly state the colour of the flame produced by a barium salt.

Limited responses

- A few candidates gave incorrect colours associated with other cations.

(f) **Comprehensive responses**

- Most candidates gave the correct expected observation.

Limited responses

- A few candidates gave incorrect observations such as fizzing.

(g) **Comprehensive responses**

- A few candidates realised that this was the sulfate test, and so gave a correct observation.

Limited responses

- Most candidates did not make the link to sulfate ion test and so stated that there would be no reaction, or that it would fizz (that being the expected observation when an acid is added to a carbonate).
- Some candidates correctly stated that barium sulfate would be formed without giving the required observation.

Question 4

Comprehensive responses

- Many candidates outlined a suitable method for producing crystals of hydrated chromium(III) nitrate.
- Some candidates planned out their answers. They wrote the experimental plan in steps, and all steps were in a logical sequence and included details such as the apparatus required.

Limited responses

- Some candidates spent time at the start of their experimental plans trying to identify dependent, independent and control variables. As this was a qualitative preparation task, there were no variables.
- Some candidates produced a list of apparatus rather than include it within the experimental plan and state what the apparatus was to be used for.
- Some candidates suggested inappropriate glassware. For example, burettes for measuring volume of a solid.

- Some candidates stated they were starting with chromium(III) nitrate without describing how to make chromium(III) nitrate.
- Many candidates did not appreciate that the chromium(III) oxide should be added in excess and instead specified that the nitric acid should be in excess.
- Many candidates did not appreciate that, because the reaction was very slow, it should be heated to increase the rate of the reaction.
- Some candidates tried to produce a solution of chromium(III) oxide at the start of the procedure.
- Some candidates described the inappropriate method of carrying out a titration.
- The need to filter the excess chromium(III) oxide from the reaction mixture prior to crystallisation was not always appreciated.
- Some candidates heated the chromium(III) nitrate to dryness and so obtained anhydrous chromium(III) nitrate which they then tried to rehydrate.