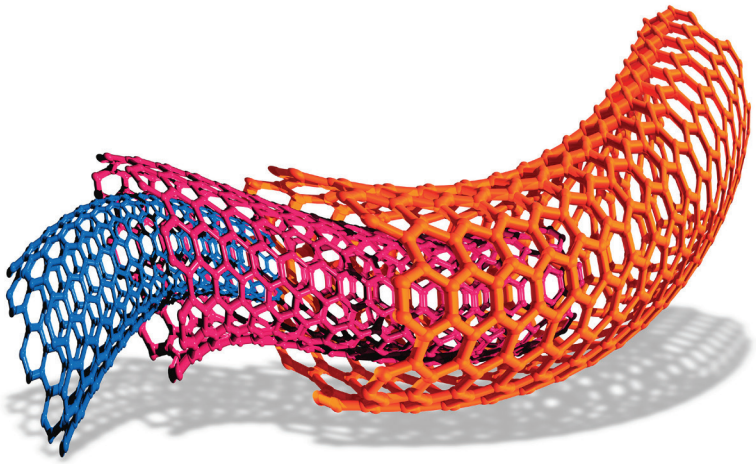
Cambridge Assessment International Education

Example Candidate Responses
Paper 3

Cambridge IGCSE™
Chemistry 0620



Version 2.0

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Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching IGCSE Chemistry (0620), and to show how different levels of candidates' performance (high, middle and low) relate to the subject's curriculum and assessment objectives.

In this booklet candidate responses have been chosen to exemplify a range of answers. Each response is accompanied by a brief commentary explaining the strengths and weaknesses of the answers.

For each question, response is annotated with clear explanation of where and why marks were awarded or omitted. This, in turn, is followed by examiner comments on how the answer could have been improved. In this way it is possible for you to understand what candidates have done to gain their marks and what they will have to do to improve their marks. At the end there is a list of common mistakes candidates made in their answers for each question.

This document provides illustrative examples of candidate work. These help teachers to assess the standard required to achieve marks, beyond the guidance of the mark scheme. Some question types where the answer is clear from the mark scheme, such as short answers and multiple choice, have therefore been omitted.

The questions, mark schemes and pre-release material used here are available to download from the School Support Hub. These files are:

Question Paper 31, June 2016	
Question paper	0620_s16_qp_31.pdf
Mark scheme	0620_s16_ms_31.pdf
Question Paper 41, June 2016	
Question paper	0620_s16_qp_41.pdf
Mark scheme	0620_s16_ms_41.pdf
Question Paper 61, June 2016	
Question paper	0620_s16_qp_61.pdf
Mark scheme	0620_s16_ms_61.pdf

Other past papers, Examiner Reports and other teacher support materials are available on the School Support Hub at www.cambridgeinternational.org/support

How to use this booklet

Example Candidate Response - middle	Examiner comments
1 Protons, neutrons and electrons are subatomic particles. (a) Complete the table to show the relative mass and relative charge of a proton, a neutron and an electron. particle / relative mass / relative charge …itive 1 …al …tive [3] …eons with same proton. …eutron 2 [2] (ii) Explain why the two isotopes of bromine have the same chemical properties. Because they are of the same element, have same number of protons 3 [2] (c) The table shows the number of protons, neutrons and electrons in some atoms and ions. Complete the table.	1 The candidate needed to realise that relative charge needs a value, so +1 and -1 …isotopes of bromine having the same number of outer electrons. Mark awarded for (b) = 2 out 4

Answers by real candidates in exam conditions. These show you the types of answers for each level.

Discuss and analyse the answers with your learners in the classroom to improve their skills.

Examiner comments are alongside the answers, linked to specific part of the answer. These explain where and why marks were awarded. This helps you to interpret the standard of Cambridge exams and helps your learners to refine exam technique.

How the candidate could have improved the answer

(b) (ii) The candidate needed to realise th… than positive and negative for proton and…

(c) The candidate failed to include the ma…

This explains how the candidate could have improved the answer. This helps you to interpret the standard of Cambridge exams and helps your learners to refine exam technique.

Common mistakes candidates made in this question

(a) Failing to give *relative* masses and *relative* cha…

(b) (i) Failing to recall that isotopes are *atoms*.

(b) (ii) Failing to state that it is the number of outer…

This describes the common mistakes candidates made in answering each question. This will help your learners to avoid these mistakes at the exam and give them the best chance of achieving a high mark.

Assessment at a glance

All candidates must enter for three papers.

Core candidates take:	Extended candidates take:
Paper 1 45 minutes A multiple-choice paper consisting of 40 items of the four-choice type. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Core syllabus content. This paper will be weighted at 30% of the final total mark.	**Paper 2** 45 minutes A multiple-choice paper consisting of 40 items of the four-choice type. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Extended syllabus content (Core and Supplement). This paper will be weighted at 30% of the final total mark.
and:	**and:**
Paper 3 1 hour 15 minutes A written paper consisting of short-answer and structured questions. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Core syllabus content. 80 marks This paper will be weighted at 50% of the final total mark.	**Paper 4** 1 hour 15 minutes A written paper consisting of short-answer and structured questions. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Extended syllabus content (Core and Supplement). 80 marks This paper will be weighted at 50% of the final total mark.

All candidates take	
either:	**or:**
Paper 5 1 hour 15 minutes Practical Test This paper will test assessment objective AO3. Questions will be based on the experimental skills in Section 7. The paper is structured to assess grade ranges A*–G. 40 marks This paper will be weighted at 20% of the final total mark.	**Paper 6** 1 hour Alternative to Practical This paper will test assessment objective AO3. Questions will be based on the experimental skills in Section 7. The paper is structured to assess grade ranges A*–G. 40 marks This paper will be weighted at 20% of the final total mark.

Teachers are reminded that the latest syllabus is available on our public website at www.cambridgeinternational.org and the School Support Hub at www.cambridgeinternational.org/support

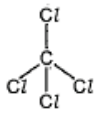
Paper 3 – Theory (Core)

Question 1

Example Candidate Response – Question 1, High	Examiner comments

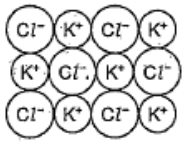
1 The structures of some substances containing chlorine are shown.

A

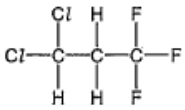


B

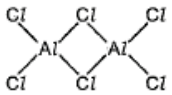
C



D



E



(a) Answer the following questions about these substances.

(i) Which substance is a diatomic molecule?

B 1 [1]

(ii) Which substance represents part of an ionic structure?

C 2 [1]

(iii) Which substance is an element?

Explain your answer.

B – it is made up of only one type of atom 3 [2]

(iv) Determine the simplest formula for substance **D**.

$C_3H_3F_3Cl_2$ 4 [1]

(b) The symbols for two isotopes of chlorine are shown.

$^{35}_{17}Cl$ $^{37}_{17}Cl$

(i) How do these two isotopes differ in their atomic structure?

Different number of ~~atoms~~ neutrons 5 [1]

(ii) Determine the number of neutrons present in one atom of the isotope $^{35}_{17}Cl$.

18 6 [1]

(iii) Draw the electronic structure of a chlorine atom. Show all shells and all electrons.

7

1 Correct. The chlorine contains two atoms so it is diatomic.

2 Correct. The ions are shown as + and −.

3 This is a concise model answer.

4 The correct molecular formula has been written.

Mark awarded for (a) = 5 out of 5

5 Correct. The top number represents the number of protons + the number of neutrons.

6 Correct. The answer obtained by 35 − 17.

7 The middle electron shell is missing and therefore 1 mark has been deducted. There should be 17 electrons because there are 17 protons. (See the bottom figures in the symbols.)

Mark awarded for (b) = 3 out of 4

Total mark awarded = 8 out of 9

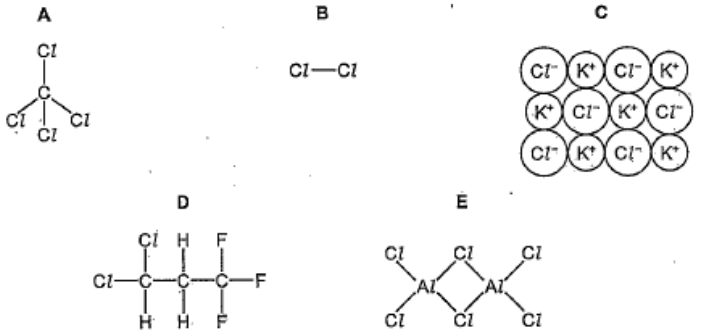
How the candidate could have improved the answer

Most answers were correct. **(a) (iii)** could be regarded as a model answer, as it gives a concise and accurate definition of an element.

(b) (iii) only gained one of the two marks because the middle electron shell was missing. If the candidate had noted that there were 17 protons, and therefore 17 electrons, in a chlorine atom, by looking carefully at the isotopic symbols in the stem of the question, they would have scored the mark.

Example Candidate Response – Question 1, Middle

1 The structures of some substances containing chlorine are shown.



(a) Answer the following questions about these substances.

(i) Which substance is a diatomic molecule?

E 1 [1]

(ii) Which substance represents part of an ionic structure?

A 2 [1]

(iii) Which substance is an element?

Explain your answer.

B because it is ONLY Cl and elements are the simplest 3 [2]

(iv) Determine the simplest formula for substance D.

~~$C_3H_3F_3Cl_2$~~ $(CHF)_3Cl_2$ 4 [1]

(b) The symbols for two isotopes of chlorine are shown.

$^{35}_{17}Cl$ $^{37}_{17}Cl$

(i) How do these two isotopes differ in their atomic structure?

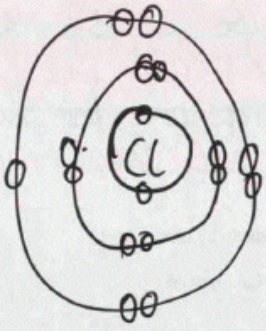
Same atomic mass but different number 5 [1]

(ii) Determine the number of neutrons present in one atom of the isotope $^{35}_{17}Cl$.

(35-17) 18 6 [1]

(iii) Draw the electronic structure of a chlorine atom. Show all shells and all electrons.

17 = 2:8:7



7

Examiner comments

1 Although E has two *types* of atom, diatomic means containing two atoms only. No mark.

2 The ionic structure is shown in these questions using + and − signs, so C is correct here, not A. No mark.

3 This contains the idea that elements contain only one type of atom.

4 This is acceptable instead of a molecular formula: $C_3H_3F_3Cl_2$.

Mark awarded for (a) = 3 out of 5

5 The essential word, either *mass* (number) or *nucleon,* (number) is missing. No mark.

6 The calculation of the number of neutrons is correct and the working is shown.

7 The correct electronic structure is shown and the electrons are paired up, which helps in counting.

Mark awarded for (b) = 3 out of 4

Total mark awarded = 6 out of 9

How the candidate could have improved the answer

(a) (i) Here the candidate chose E and not C, perhaps because it had two types of atom. The candidate could have obtained this mark if they had realised that *diatomic* means two atoms in a molecule and not two *types* of atom in a molecule.

(a) (ii) Here the candidate chose A instead of C through not realising that ionic structures will be shown in this type of question with + and − charges.

1(a) (iii) was acceptable, but a more formal definition such as 'it has only one type of atom' would have been an improvement.

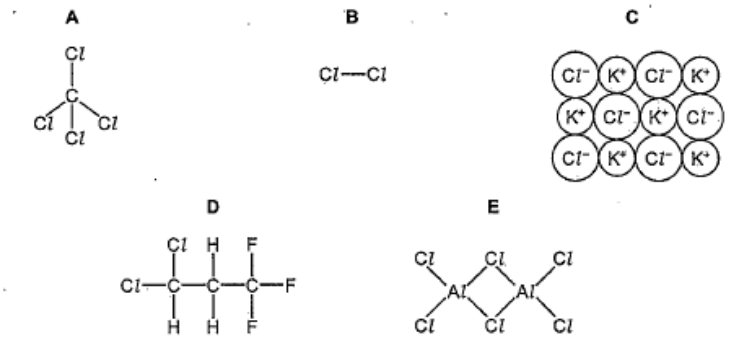
(a) (iv) was acceptable but a standard molecular formula $C_3H_3F_3Cl_2$ would have been better.

(b) (i) A mark was not gained for because the essential word *mass* (or *nucleon*) was omitted. Candidates should make sure that they name the particle that the number refers to.

(b) (iii) gained both marks. Candidates should always be encouraged to pair up the electrons, as shown in this answer.

Example Candidate Response – Question 1, Low

1 The structures of some substances containing chlorine are shown.



(a) Answer the following questions about these substances.

(i) Which substance is a diatomic molecule?

E 1 [1]

(ii) Which substance represents part of an ionic structure?

C 2 [1]

(iii) Which substance is an element?

Explain your answer.

B is an element because it has only one type of atom. 3 [2]

(iv) Determine the simplest formula for substance D.

$C_2H_3F_3$ 4 [1]

(b) The symbols for two isotopes of chlorine are shown.

$^{35}_{17}Cl$ $^{37}_{17}Cl$

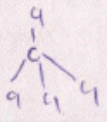
(i) How do these two isotopes differ in their atomic structure?

They have different numbers of electrons and protons 5 [1]

(ii) Determine the number of neutrons present in one atom of the isotope $^{35}_{17}Cl$.

18 6 [1]

(iii) Draw the electronic structure of a chlorine atom. Show all shells and all electrons.



Examiner comments

1 Although E has two *types* of atom, *diatomic* means containing two atoms only. No mark.

2 The ionic structure is shown in these questions using + and − signs, so C is correct.

3 Correct definition of an element.

4 The carbon atoms have not been counted. No mark.

Mark awarded for (a) = 3 out of 5

5 The incorrect particles have been given here. There are different numbers of neutrons. No mark.

6 This has been calculated correctly (35 − 17) from the symbols above.

7 Structure A has been redrawn instead of the electronic structure requested in the instruction. No mark.

Mark awarded for (b) = 1 out of 4

Total mark awarded = 4 out of 9

How the candidate could have improved the answer

(a) (i) Here the candidate chose E and not C, perhaps because it had two types of atom. The candidate might have obtained this mark if they had realised that *diatomic* means two atoms in a molecule and not two *types* of atom in a molecule.

(a) (iii) This is a model answer, as it contains a concise and accurate definition of an element.

(a) (iv) Here the carbon atoms were omitted. This type of error could be prevented by counting each type of atom and crossing them out on the diagram one by one as they are counted.

(b) (i) This answer did not mention neutrons. The mark could have been gained if the candidate had remembered that the upper figure (nucleon number) in isotopes is different because of the different number of neutrons.

(b) (iii) The candidate redrew structure A. They could have improved by reading the instruction more carefully and noting the word 'electronic'.

Common mistakes candidates made in this question

(a) (i) The word *diatomic* was often incorrectly applied to potassium chloride, perhaps because it contains two different ions. The correct answer is B because it contains two *atoms* that are the same.

(a) (ii) The commonest error was to suggest structure A (CCl_4) or structure E (Al_2Cl_6) rather than looking for the + and − charges which would indicate an ionic structure.

(a) (iii) The definition of the word *element* was often incorrectly applied because candidates referred to substances or molecules rather than atoms. Some wrote incorrectly about mixtures or compounds or about 'substances containing only one atom' instead of 'one type of atom'.

(a) (iv) The commonest errors involved the incorrect counting of atoms, especially the chlorine and fluorine atoms, or repeating the atoms, for example $CH_2CHF_3Cl_2$ instead of $C_3H_3F_3Cl_2$.

(b) (i) The commonest error was to suggest that there was a different number of protons or electrons rather than neutrons. Some candidates referred incorrectly to differences in relative atomic masses.

(b) (ii) Some candidates added the atomic masses of the isotopes or added the top number to the bottom number, instead of taking the number of protons (bottom number) away from the top number (mass number).

(b) (iii) A common error was to draw a chlorine molecule instead of a chlorine atom as a result of misreading the instruction. Some candidates did not draw the second shell of eight electrons.

Question 2

Example Candidate Response – Question 2, High

2 A bicycle maker wants to choose a suitable material to make bicycle frames.
The table shows the properties of some materials that could be used.

material	relative strength	density in g/cm^3	resistance to corrosion	cost per tonne in $/tonne
aluminium	8	2,7	very good	1500
iron	21	7.9	poor	450
stainless steel	24	7.9	very good	600
titanium	27	4.5	very good	15000
zinc	14	7.1	good	1300

(a) Which material is the most suitable for making the bicycle frame?

Explain your answer using information from the table.

Stainless steel because it is strong, resistant to corrosion, and very cheap. 1

[3]

(b) Aluminium is extracted from aluminium oxide by electrolysis.

(i) State the name of the main ore of aluminium.

Bauxite 2 [1]

(ii) Suggest why aluminium is extracted by electrolysis and **not** by reduction with carbon.

Its easier to do large amounts of it 3 [1]

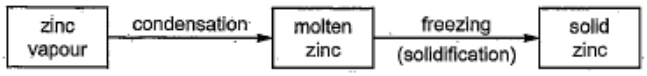
(iii) Molten aluminium oxide is electrolysed using graphite electrodes.

Predict the products of this electrolysis at

the positive electrode (anode), Oxygen 4

the negative electrode (cathode). Aluminium [2]

(c) The diagram shows the changes of state when zinc vapour is cooled slowly to room temperature.



Explain what happens during these changes in terms of

- the distance between the particles,
- the type of motion shown by the particles.

During condensation, the particles get closer together and move slower, but still are moving. 5

During freezing particles get very close together, 6 and barely move at all. 7

[4]

Examiner comments

1 'Stainless steel' with three correct reasons scores a full three marks.

Mark awarded for (a) =
3 out of 3

2 The commonest ore of aluminium has been chosen.

3 The ease of extraction is related incorrectly to the amount of material. Aluminium is a reactive metal so it is extracted by electrolysis. Carbon is used to extract less reactive metals such as iron. No mark.

4 The anode and cathode products have been identified correctly.

Mark awarded for (b) =
3 out of 4

5 Mentioning the closer and slower movement of the particles during condensation earns marks.

6 This conveys the idea that the particles in a solid are very close (touching).

7 This suggests that the particles *do* move (from place to place). The word *vibrate* is required here.

Mark awarded for (c) =
3 out of 4

Total mark awarded =
9 out of 11

How the candidate could have improved the answer

(a) Here the best metal was chosen and its three properties were given clearly and concisely.

(b) (ii) Here the ease of extraction of the metal was related to the quantity of metal instead of to the metal's reactivity. The candidate could have improved their mark by remembering that electrolysis is used to extract reactive metals but carbon is used to extract less reactive metals. The instruction hints at this.

(c) Marks were gained for the idea of the particles getting closer and moving more slowly during condensation. The idea that 'during freezing the particles are close together in a solid' was given the benefit of the doubt. This statement could be have been improved simply by writing that 'the particles are close together in the solid'. The statement that particles barely move in the solid was not given credit because it suggests that they *do* move (from place to place). An improvement would have been 'the particles do not move' or 'the particles only vibrate'.

Example Candidate Response – Question 2, Middle

2 A bicycle maker wants to choose a suitable material to make bicycle frames.
The table shows the properties of some materials that could be used.

material	relative strength	density in g/cm^3	resistance to corrosion	cost per tonne in $/tonne
aluminium	8	2.7	very good	1500
iron	21	7.9	poor	450
stainless steel	24	7.9	very good	600
titanium	27	4.5	very good	15000
zinc	14	7.1	good	1300

(a) Which material is the most suitable for making the bicycle frame?

Explain your answer using information from the table.

Stainless steel because it is very strong, 1
It is very dense and has good
resistance to corrosion. but And it 2
is not as ex is not too expensive [3]

(b) Aluminium is extracted from aluminium oxide by electrolysis.

(i) State the name of the main ore of aluminium.

bauxite 3 [1]

(ii) Suggest why aluminium is extracted by electrolysis and **not** by reduction with carbon.

because it is not too reactive 4 [1]
Not reactive ~~a good conductor of electri~~

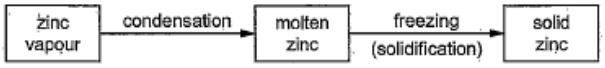
(iii) Molten aluminium oxide is electrolysed using graphite electrodes.

Predict the products of this electrolysis at

the positive electrode (anode), graphite 5

the negative electrode (cathode). Aluminium oxide 6 [2]

(c) The diagram shows the changes of state when zinc vapour is cooled slowly to room temperature.



Explain what happens during these changes in terms of

- the distance between the particles,
- the type of motion shown by the particles.

Firstly, the particles slowly start
to move closer and closer until 7
they are alingned and fixed at solid zinc. 8
~~See~~ Secondly, the particles tend to move
less and less 9 [4]

Examiner comments

1 'Stainless steel' with three correct reasons scores a full three marks.

2 This was ignored.

Mark awarded for (a) = 3 out of 3

3 The correct ore of aluminium has been identified.

4 Incorrect. Aluminium is high in the reactivity series but appears unreactive if not freshly made because of its unreactive oxide layer. Very reactive metals are extracted by electrolysis.

5 Graphite is the anode not the product at the anode (which is oxygen).

6 Aluminium oxide is the electrolyte not the product at the cathode (which is aluminium).

Mark awarded for (b) = 1 out of 4

7 Contains the idea of moving closer.

8 The arrangement is not asked for in the instruction.

9 Contains the idea of slower movement.

Mark awarded for (c) = 2 out of 4

Total mark awarded = 6 out of 11

How the candidate could have improved the answer

(a) (i) Here the best metal was chosen and its three properties were given clearly and concisely.

(b) (ii) Here the candidate got muddled about the reactivity, thinking that aluminium is unreactive. They needed to remember that electrolysis is used to extract reactive metals, but carbon is used to extract less reactive metals. The instruction hints at this.

(b) (iii) The candidate did not respond correctly to the word 'products' in the instruction, giving the name of the material making the anode and the electrolyte instead. They needed to clearly distinguish the terms *products*, *electrodes* and *electrolyte*.

(c) Benefit of the doubt was given for suggesting that the particles move closer and move less. The answer could have been improved by stating that this happens during condensation. The comments about particles being fixed and aligned were not relevant because the bullet points in the question referred only to the distance between the particles and their motion.

Common mistakes candidates made in this question

(a) The commonest error was to quote values from the table without adding comments such as 'high strength' or 'cheap'. Some candidates chose metals for the bicycle frame which limited their marks, e.g. zinc.

(b) (i) The commonest incorrect answer was 'hematite' (the ore of iron). Other incorrect answers included 'aluminium oxide', which is a pure compound and not an ore, or 'aluminium ore' which just repeats information from the instruction. A few candidates gave answers which were too different from the correct one (bauxite), for example, 'boxerd'.

(b) (ii) The commonest error was to suggest that aluminium reacts with carbon rather than referring to the position of aluminium in the reactivity series. Just writing 'aluminium is reactive' alone was not enough. Candidates needed to make a comparison with carbon.

(b) (iii) A common error was to suggest that hydrogen is formed at the negative electrode (perhaps through thinking that a solution was being electrolysed rather than the liquid). Other candidates gave products which were not present in aluminium oxide, for example, chlorine.

(c) The main error when writing about changes of state was not making clear which states were being referred to. Many candidates thought incorrectly that atoms get much closer together during freezing. Another common error was to suggest that the particles move from place to place in a solid.

Question 3

Example Candidate Response – Question 3, High

3 The table shows some properties of the Group I metals.

metal	density in g/cm^3	melting point /°C	boiling point /°C
lithium	0.53	181	1342
sodium		98	883
potassium	0.86	63	760
rubidium	1.53	39	686
caesium		29	669

(a) (i) Describe the trend in boiling points of the Group I metals.

The decreases as it goes down. 1 [1]

(ii) Predict the density of caesium.

2.5 2 [1]

(iii) Deduce the state of caesium at 20 °C.

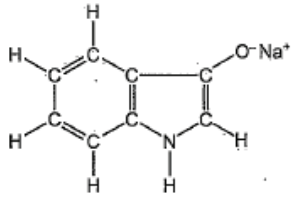
Explain your answer.

Solid because it ~~boils~~ ~~that~~ melts at 29°C. 3 [2]

(b) Complete the word equation for the reaction of rubidium with water.

rubidium + water → rubidium oxide 4 + Hydrogen 5 [2]

(c) The dye, indigotin, is formed when compound F is exposed to air.
The structure of compound F is shown below.



Complete the table and calculate the relative molecular mass of compound F.

type of atom	number of atoms	atomic mass	molecular mass
carbon	8	12	8×12=96
hydrogen	6	1	~~6×6=6~~ 6×1=6
nitrogen	1	14	1×14=14
oxygen	1	16	1×16=16
sodium	1	23	~~23×1=23~~ 1×23=23

relative molecular mass = 155 [2] 6

Examiner comments

1 This is just sufficient: 'down the Group' would have been better.

2 Just within the range allowed.

3 There must be a comparison with the quoted temperature of 20 °C to get the mark. 1 mark was lost.

Mark awarded for (a) = 3 out of 4

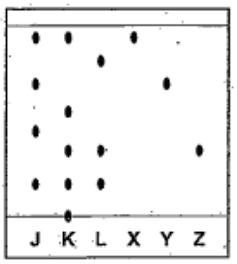
4 A reactive metal reacting with cold water produces the hydroxide not the oxide.

5 Correct.

Mark awarded for (b) = 1 out of 2

6 The working is correct here, as well as the answer.

Mark awarded for (c) = 2 out of 2

Example Candidate Response – Question 3, High	Examiner comments
(d) Three dye mixtures, **J**, **K** and **L**, were spotted onto a piece of chromatography paper. Three pure dyes, **X**, **Y** and **Z**, were also spotted onto the same piece of paper. The diagram shows the results of this chromatography.  (i) Suggest why the base line was drawn in pencil and **not** in ink. because pencil is insoluble. Ink is soluble [1] 7 (ii) Which dye mixture, **J**, **K** or **L**, contains a dye which did **not** move during this chromatography? K [1] 8 (iii) Which dye mixture, **J**, **K** or **L**, contains both dye **X** and dye **Y**? J [1] 9 (iv) Which dye mixture, **J**, **K** or **L**, does **not** contain dye **Z**? J [1] 10	7 A good answer which mentions the solubility/insolubility of both pencil and ink. 8 Correct. 9 Correct. 10 Correct. Mark awarded for (d) = 4 out of 4 **Total marks awarded = 10 out of 12**

How the candidate could have improved the answer

(a) (ii) The value of 2.5 was acceptable but on the limit. The difference in density between potassium and rubidium is 0.67 so the examiners were expecting values around 2.2 (1.53 + 0.67).

(a) (iii) The answer 'melts at 29 °C' is insufficient for the second mark because this just repeats information from the table. To gain the extra mark, the candidate needed to mention that 20 °C is below 29 °C.

(b) Here rubidium oxide was given as a product instead of rubidium hydroxide. Candidates should remember that the reaction of a reactive metal with cold water produces a hydroxide and hydrogen.

Example Candidate Response – Question 3, Middle

Examiner comments

3 The table shows some properties of the Group I metals.

metal	density in g/cm^3	melting point /°C	boiling point /°C
lithium	0.53	181	1342
sodium		98	883
potassium	0.86	63	760
rubidium	1.53	39	686
caesium		29	669

(a) (i) Describe the trend in boiling points of the Group I metals.

temperatures decrease 1 [1]

(ii) Predict the density of caesium.

2.02 g/cm^3 2 [1]

(iii) Deduce the state of caesium at 20 °C.

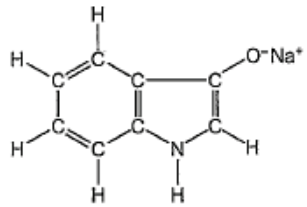
Explain your answer.

~~Molten liquid at 20°C~~ caesium would be a solid at 20°C in a fixed position 3 [2]

(b) Complete the word equation for the reaction of rubidium with water.

rubidium + water → rubidium oxide 4 + Hydrogen 5 [2]

(c) The dye, indigotin, is formed when compound **F** is exposed to air.
The structure of compound **F** is shown below.



Complete the table and calculate the relative molecular mass of compound **F**.

type of atom	number of atoms	atomic mass	
carbon	8	12	8×12=96
hydrogen	6	1	6x1 = 6
nitrogen	1	14	1×14=14
oxygen	1	16	1×16=16
sodium	1	23	1x23 = 32

6

relative molecular mass = 164 [2]

1 No mark here because there is no mention of whether or not the temperature decreases down the Group or up the Group.

2 This is within the range allowed.

3 The candidate gives 20 °C but there is no reference to this temperature being lower than the melting point. The 'fixed position' is not necessary since the question does not ask about kinetic particle theory.

Mark awarded for (a) =
2 out of 4

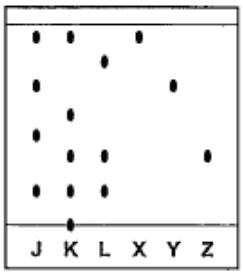
4 A reactive metal reacting with cold water produces the hydroxide not the oxide.

5 Correct.

Mark awarded for (b) =
1 out of 2

6 The figures showing the product of multiplication have been written incorrectly for sodium. The answer should be 23 (not 32). But 1 mark has been awarded for the correct row (hydrogen).

Mark awarded for (c) =
1 out of 3

Example Candidate Response – Question 3, middle	Examiner comments
(d) Three dye mixtures, **J**, **K** and **L**, were spotted onto a piece of chromatography paper. Three pure dyes, **X**, **Y** and **Z**, were also spotted onto the same piece of paper. The diagram shows the results of this chromatography.  **(i)** Suggest why the base line was drawn in pencil and **not** in ink. To not ruin the ink from spreading on to the paper. [1] **(ii)** Which dye mixture, **J**, **K** or **L**, contains a dye which did **not** move during this chromatography? K [1] **(iii)** Which dye mixture, **J**, **K** or **L**, contains both dye **X** and dye **Y**? J [1] **(iv)** Which dye mixture, **J**, **K** or **L**, does **not** contain dye **Z**? J [1]	**7** This answer is too vague. The word 'not' negates a correct answer. 'To stop the ink spreading on the paper' would have earned a mark. **8** Correct. **9** Correct. **10** Correct. Mark awarded for (d) = 3 out of 4 **Total marks awarded = 7 out of 12**

How the candidate could have improved the answer

(a) (i) The answer just stating 'temperatures decrease' was too simple. In order to gain the mark, the candidate should have written about the position of the metal in the Group as well.

(a) (iii) The reason was given in terms of kinetic particle theory instead of extracting information from the table. To gain the extra mark, the candidate needed to state that 20 °C is below 29 °C.

(b) Here rubidium oxide was given as a product instead of rubidium hydroxide. Candidates should remember that the reaction of a reactive metal with cold water produces a hydroxide and hydrogen.

(c) A mark was given for the hydrogen row being correct. The second mark would have been gained if the candidate had not reversed the 3 and the 2 ('1 x 23 = 32') in the sodium row. Repeating the calculation a second time might have highlighted this error.

(d) (i) The answer was too vague and suggested that the ink does not spread. In order to gain the mark, the candidate needed to state clearly that the ink spreads or that it dissolves in water.

Common mistakes candidates made in this question

(a) (i) The commonest error was not to link the trend in boiling point with the direction up or down the Group. The answer 'goes down' was not precise enough. Another common error was to link boiling point to density or melting point rather than -position in the Group.

(a) (ii) The commonest error was not to follow the trend in the densities and to give values that were far too high, e.g. 10 g/ cm^3. Some candidates gave a possible density for sodium (between 0.53 and 0.86) rather than for caesium.

(a) (iii) Many did not gain the second mark because they referred to the value of the melting point without stating that 20 °C is below the melting point. Others referred incorrectly to the boiling point. Another common error was to suggest that caesium is liquid at 20 °C.

(b) The commonest error was to suggest that rubidium oxide is formed (rather than rubidium hydroxide). 'Water' or 'carbon dioxide' were often given as incorrect products in place of hydrogen. Some candidates gave the names of compounds which did not include rubidium hydrogen or oxygen.

(c) Errors in addition often caused marks to be lost here. Some candidates multiplied the number of atoms by the atomic mass to get values which were far too high.

(d) (i) The commonest error was to suggest that the ink reacts.

(d) (ii) The commonest error was to suggest mixture K instead of mixture J.

(d) (iii) The commonest error was again to suggest mixture K instead of mixture J.

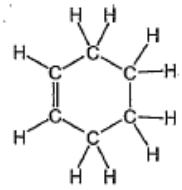
(d) (iv) Mixture K was again the commonest incorrect answer.

Question 4

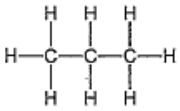
Example Candidate Response – Question 4, High	Examiner comments

4 The structures of some organic compounds are shown.

P



Q



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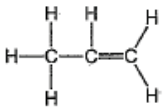
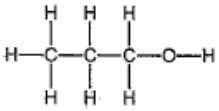
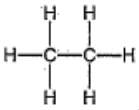


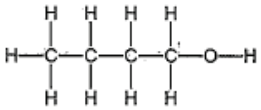
S



T



U



(a) **(i)** Which **two** of these compounds are alcohols?

Explain your answer.

S and U, they are alcohols because they belong to the same homologous series and have the same functional group. [2] 1

(ii) Which **two** of these compounds are saturated hydrocarbons?

Q and T. 2 [1]

(b) Methanol and ethanol are alcohols in the same homologous series.

Complete the following sentence about a homologous series using words from the list.

alcohols	**chemical**	**compounds**	**elements**
functional	**mixtures**	**physical**	

A homologous series is a family of similar compounds with similar physical properties due to the same functional group. [3] 3

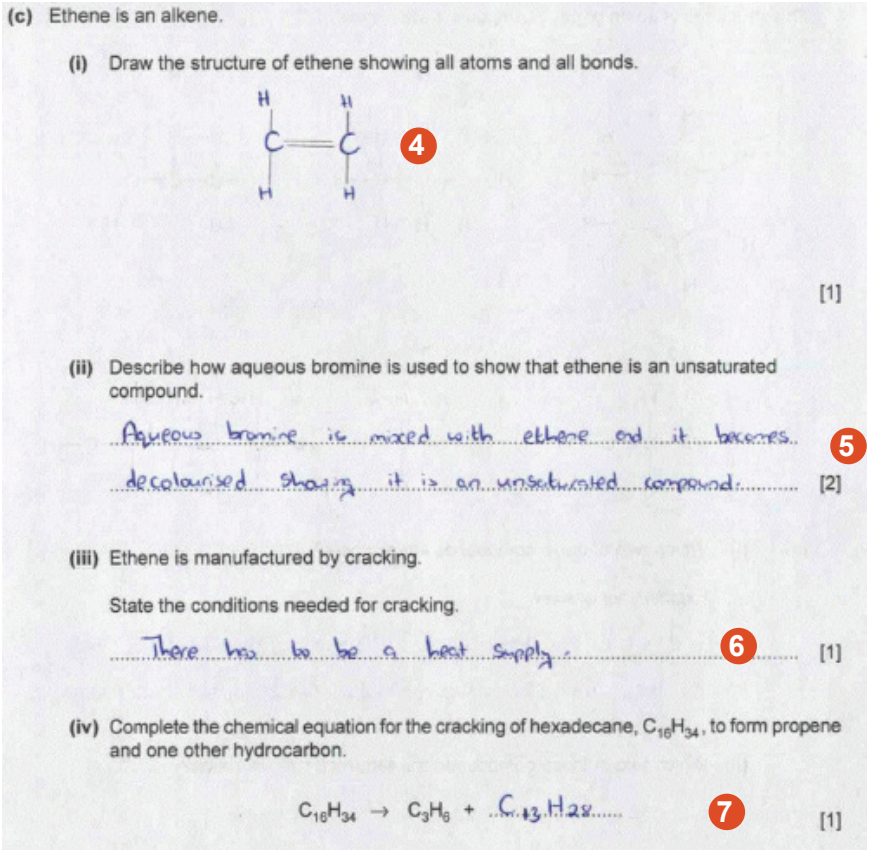
1 The alcohols are correctly identified but the second mark requires the identification of the functional group as OH.

2 These have been identified correctly. They are carbon compounds containing only single bonds.

Mark awarded for (a) = 2 out of 3

3 The only error is the suggestion of a trend in physical properties. In a homologous series there is a trend in physical properties and not a similarity. The similarity in the functional group makes the chemical properties similar.

Mark awarded for (b) = 2 out of 3

Example Candidate Response – Question 4, High	Examiner comments
	4 The structure shows all the bonds and all the atoms correctly. 5 Both mixing bromine with ethene and decolourisation are mentioned here. 6 The word 'heat' is sufficient for the mark here. 7 The equation has been balanced correctly. Mark awarded for (c) = 5 out of 5 **Total mark awarded = 9 out of 11**

How the candidate could have improved the answer

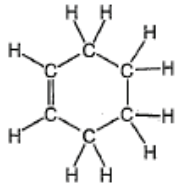
(a) (i) The answer 'the same functional group' was not accurate enough because compounds P and R also have the same functional group. The question asks about the alcohol functional group rather than the functional group present in the alkenes. The candidate would have gained the extra mark by writing about the -OH group.

(b) The candidate suggested that a homologous series has the same physical properties rather than chemical properties. Knowledge of examples of physical properties, for example, melting points and densities would have helped to gain this mark.

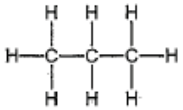
Example Candidate Response – Question 4, Low

4 The structures of some organic compounds are shown.

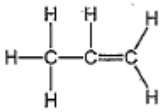
P



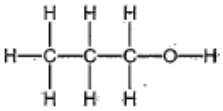
Q



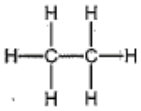
R



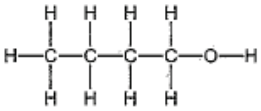
S



T



U



(a) **(i)** Which **two** of these compounds are alcohols?

Explain your answer.

S and U because there structures are drawn like this. [2]

1

(ii) Which **two** of these compounds are saturated hydrocarbons?

P & R [1]

2

(b) Methanol and ethanol are alcohols in the same homologous series.

Complete the following sentence about a homologous series using words from the list.

alcohols	**chemical**	**compounds**	**elements**
functional	**mixtures**	**physical**	

A homologous series is a family of similar mixtures 3, with similar physical 4 properties due to the same elements 5 group. [3]

Examiner comments

1 The alcohols have been identified correctly but no reference has been made to the OH functional group.

2 The unsaturated hydrocarbons have been identified (C=C double bond) rather than the saturated hydrocarbons (only single C–C bonds).

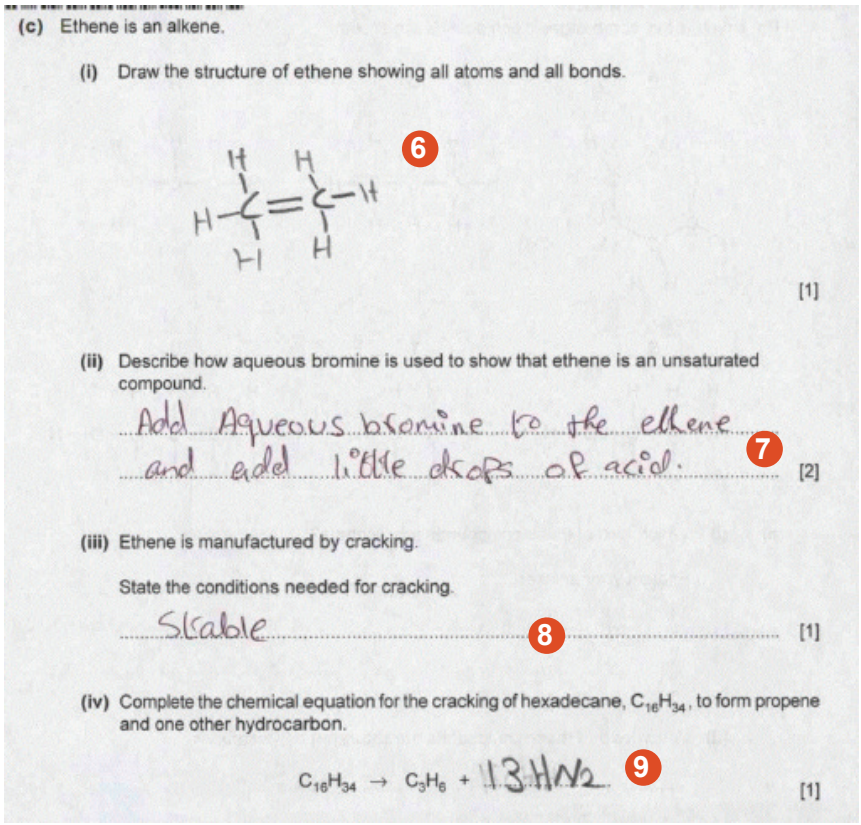
Mark awarded for (a) = 1 out of 3

3 Methanol and ethanol are both compounds and not mixtures.

4 In a homologous series there is a trend in physical properties and not a similarity. The similarity in the functional group makes the chemical properties similar.

5 The similarity between methanol and ethanol is in their functional group (OH). They are not elements because they have different types of atoms bonded together.

Mark awarded for (b) = 0 out of 3

Example Candidate Response – Question 4, Low	Examiner comments
	6 Each carbon atom has five bonds in this structure. There should be four bonds to each carbon atom, so one hydrogen atom from each carbon should be removed (with its bond) to get the correct structure. 7 The correct reagent has been added, although the acid has been ignored. There is also no description of what happens (bromine decolourised). 8 The word 'stable' is not accurate enough. Conditions are things such as pressure, temperature or catalyst. 9 The equation has not been balanced correctly and the answer suggests guesswork rather than an attempt to subtract the carbon (16−3 = 13C) and hydrogen (34−6 = 28H). Mark awarded for (c) = 1 out of 5 **Total marks awarded = 2 out of 11**

How the candidate could have improved the answer

4 (a) (i) This response was far too vague. The mark could have been obtained by noting that both compounds contain the -OH group.

4 (a) (ii) Here the candidate muddled the terms *saturated* and *unsaturated* and therefore gave the incorrect answer: P and R. Candidates need to be clear that unsaturated compounds have C=C double bonds.

4 (b) The candidate suggested that a homologous series has the same *physical* properties rather than chemical properties. Knowledge of examples of physical properties, for example, melting points and densities would have helped gain this mark. Rote learning of definitions which appear in the syllabus would also help candidates improve their marks and help reduce errors such as suggesting that compounds are mixtures.

4 (c) (i) The candidate showed the double bonds but attached extra hydrogen atoms to each carbon. The mark could have been obtained by remembering that a carbon atom can usually only form four bonds to other atoms.

4 (c) (ii) There was no description of the result of the test. This mark could have been obtained by noting the command word 'describe' in the instruction. This implied that both a test and the result were needed here.

4 (c) (iii) There was misunderstanding of the term 'conditions'. The mark could have been obtained if temperature, pressure or catalyst had been referred to.

The candidate may have realised in **4 (c) (iv)** that there were 13 carbon atoms (13 in front of HN_2). In order to gain the mark, the candidate should have understood that there must be the same number of each type of atom on each side of the equation.

Common mistakes candidates made in this question

4 (a) (i) One common error was to write comments about the structure of alcohols which were not accurate enough, for example, 'They contain hydrogen and oxygen'. Another common error was to choose Q and S, which both contain three carbon atoms.

4 (a) (ii) Repeating the answer to (a) (i) by choosing compounds S and U was a common error. Other candidates did not gain the mark because they wrote either Q or T combined with either S or U.

4 (b) The commonest errors were putting the word 'elements' in the first gap and/or putting the word 'compounds' in the third gap.

4 (c) (i) Common errors included: drawing the structure of ethane; drawing carbon atoms with five bonds; the inclusion of –OH groups; drawing a single bond between the carbon atoms. A number of candidates drew the structure of pentene instead of ethene.

4 (c) (ii) Common errors included: suggesting that ethane turns colourless; no reaction; stating why the change occurred rather than giving a description of the colour change. A change from brown to clear (instead of colourless) was occasionally an incorrect answer.

4 (c) (iii) Many candidates gave the names of chemicals to be added instead of the reaction conditions. Others gave inaccurate descriptions such as 'warm' (instead of 'heat'). Many omitted to mention a catalyst.

4 (c) (iv) Incorrect subtraction of numbers of atoms resulted in the most errors, for example, answers such as $C_{13}H_{28}$. Others added $C_{16}H_{34}$ to C_3H_6.

Question 5

Example Candidate Response – Question 5, Middle	Examiner comments

5 The Group VII elements are called the halogens.

(a) Describe the trends in

- the physical properties of the halogens,
- the reactivity of halogens with other halide ions.

Include a relevant word equation in your answer.

Halogens are inert ~~gases~~ gases. ~~They are metals~~

They have coloured flames.

Their melting and boiling points increase down the group. 1

Halogens do not react with other halide ions. Their densities increase down the group. 2 3 [5]

(b) Iodine reacts with hot concentrated nitric acid.

$$I_2 + 10HNO_3 \rightarrow 2HIO_3 + 4H_2O + 10NO_2$$

(i) Explain why this reaction could have an adverse effect on health if not carried out in a fume cupboard.

Nitrogen oxides are released which have 4 harmful effects when inhaled. 5 [2]

(ii) Nitric acid is strongly acidic.

Which one of the following pH values represents a strongly acidic solution?

Put a ring around the correct answer.

pH 1 pH 7 pH 9 (pH 13) 6

[1]

(iii) Nitric acid reacts with zinc oxide.

State the names of the products of this reaction.

Zinc nitrate 7 and oxygen 8 [2]

1 Two trends are identified (melting and boiling points increase down the Group).

2 The wording of the instruction suggests that the halogens do react with the halide ions. (A more reactive halogen displaces a less reactive halogen from a solution of its halide ions.)

3 The trend in density is identified.

Mark awarded for (a) = 3 out of 5

4 Credit has been given for the identification of an oxide of nitrogen. A better answer would have been to name nitrogen dioxide.

5 'Harmful' is not sufficient to gain a mark here. A definite effect, e.g. 'irritates the lungs' is required.

6 Incorrect: acids have pH values below pH 7.

7 The salt is correctly identified here.

8 Water is formed (not oxygen) when an acid reacts with a metal oxide.

Mark awarded for (b) = 2 out of 5

Total marks awarded = 5 out of 10

How the candidate could have improved the answer

(a) This candidate has clearly taken note of the instructions here and written well about the trends, scoring one mark for each. The answer could have been improved by including the idea that a more reactive halogen displaces a less reactive halogen from a halide, and by including a word equation.

(b) (i) The suggestion that nitrogen dioxide is harmful is not accurate enough to gain the second mark. The examiners expected a specific effect on the body such as 'irritates the eyes or throat'.

(b) (ii) The highest pH was selected instead of the lowest. A common error is to think that the acidity must be higher because the pH is higher.

(b) (iii) It is important that candidates remember the general reactions mentioned in the syllabus. More marks could have been obtained by applying the pattern: 'metal oxide + acid → salt + water'.

Example Candidate Response – Question 5, Low

5 The Group VII elements are called the halogens.

(a) Describe the trends in

- the physical properties of the halogens,
- the reactivity of halogens with other halide ions.

Include a relevant word equation in your answer.

Halogens are ~~very~~ reactive but as ~~we go down~~ the lower you go in the ~~down~~ the reactivity. for example: Chlorine is more reactive than Iodine. 1

Halogens usually have very dark colors. for example: Iodine is very black and sometimes dark green. 2

[5]

(b) Iodine reacts with hot concentrated nitric acid.

$$I_2 + 10HNO_3 \rightarrow 2HIO_3 + 4H_2O + 10NO_2$$

(i) Explain why this reaction could have an adverse effect on health if not carried out in a fume cupboard.

This reaction would have an adverse effect on health because it contains a lot of nitric acid. 3 [2]

(ii) Nitric acid is strongly acidic.

Which one of the following pH values represents a strongly acidic solution?

Put a ring around the correct answer.

pH 1 (4) pH 7 pH 9 pH 13

[1]

(iii) Nitric acid reacts with zinc oxide.

State the names of the products of this reaction.

Nitric oxide and ~~Zinc~~ water; 5 [2]

Examiner comments

1 This is not quite enough to gain a mark. The question asks for the reactivity of halogens with halide ions. The mark would have been given if there had been mention of a more reactive halogen displacing a less reactive halogen (from the halide). No trends in physical properties have been identified.

2 This is a trend in chemical properties. No trends in physical properties have been identified. Only the colour of the iodine has been mentioned (and the green conflicts with the black).

3 The examiners were expecting a reference to a gas, not to the acid, because the information in the instruction referred to a fume cupboard.

Mark awarded for (a) = 0 out of 5

4 Correct. Acids have pH values below pH 7.

5 'Water' is a correct product. The other product should be 'zinc nitrate' (acid + metal oxide produces a salt + water).

Mark awarded for (b) = 2 out of 5

Total mark awarded = 2 out of 10

How the candidate could have improved the answer

(a) This candidate could have improved by taking more careful note of the instructions, which ask for trends in the *physical* properties such as melting point or density, not in the *chemical* properties such as reactivity. There was also no mention of reactivity with halide ions, as requested in the second bullet point. The marks could also have been improved if the colours of two other halogens had been mentioned, outlining a trend in depth of colour from light green to dark red-brown to black.

(b) (i) Marks could have been higher here if the hint in the instructions had been followed: the use of a fume cupboard suggests that a gas should be selected from the equation, not an acid.

(b) (iii) It is important that candidates remember the general reactions mentioned in the syllabus. The mark could have been improved by applying the pattern: 'metal oxide + acid → salt + water'.

Common mistakes candidates made in this question

(a) The best candidates only scored three marks for this question. The instructions were either ignored or misread by many candidates, who did not appear to note or understand the words 'trends' or 'physical properties'. Common errors included: not identifying trends; stating properties of individual halogens; and misunderstanding what happens in displacement reactions. Many candidates either missed out writing word equations, or made one or more of the products identical to the reactants.

(b) (i) Many wrote that the effect of nitrogen dioxide was just 'harmful' or 'poisonous' rather than giving a particular effect on respiration, the throat or eyes.

(b) (ii) The commonest error was to choose pH 13.

(b) (iii) Many gave 'zinc' or 'zinc oxide' in place of 'zinc nitrate'. Others wrote 'hydrogen' or 'oxygen' instead of 'water'. Some candidates wrote down elements or compounds which were not present in the reactants, for example, 'lead'.

Question 6

Example Candidate Response – Question 6, High	Examiner comments

6 Ammonia is manufactured by the reaction of nitrogen with hydrogen in the presence of a catalyst.

(a) What is the purpose of a catalyst?

to speed up the reaction with [1]

(b) The reaction is reversible.

Complete the equation below by adding the sign for a reversible reaction.

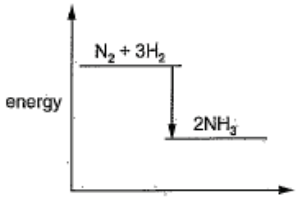
$N_2 + 3H_2 \rightleftharpoons 2NH_3$

[1]

(c) The energy level diagram for this reaction is shown.

Is this reaction exothermic or endothermic?

Give a reason for your answer.



endo ther endothermic because it is losing heat to losing energy. [1]

1 Correct.

Mark awarded for (a) = 1 out of 1

2 The sign for a reversible reaction is correct.

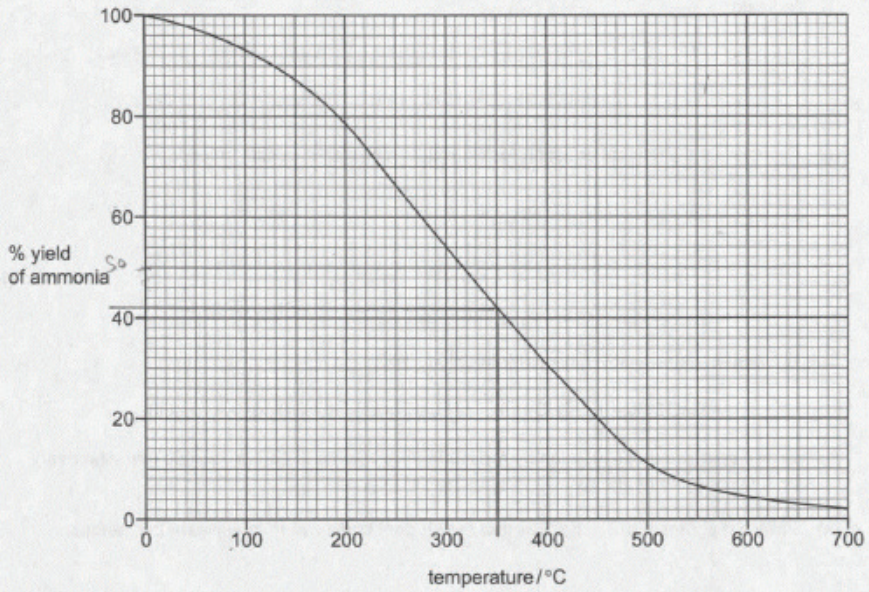
Mark awarded for (b) = 1 out of 1

3 Although the reason given here ('losing energy') is correct, this means that energy is being given out (exothermic).

Mark awarded for (c) = 0 out of 1

Example Candidate Response – Question 6, High	Examiner comments

(d) The graph shows how the percentage yield of ammonia changes with temperature when the pressure is kept constant.



(i) Describe how the percentage yield of ammonia changes with temperature.

The higher the temperature the less % of yield of ammonia [1]

4

(ii) Determine the percentage yield of ammonia at 350°C.

42% 5 [1]

(e) Describe a test for ammonia.

test red litmus paper

result turns blue. 6 [2]

(f) Ammonia is a weak base.

Describe how you would measure the pH of an aqueous solution of a weak base using Universal Indicator.

add 2-3 drops of universal indicator,

universal indicator should turn green-blue 7 [2]

(g) Complete the chemical equation for the reaction of ammonia with chlorine.

$2NH_3 + 3Cl_2 \rightarrow N_2 + 6HCl$ 8 [2]

4 Both yield and temperature have been referred to here, so this gains the mark.

5 Correct.

Mark awarded for (d) = 2 out of 2

6 The test and the result are correct. The answer could have been improved by giving the test as '*damp* red litmus paper'.

Mark awarded for (e) = 2 out of 2

7 The idea of adding the Universal Indicator to the solution has been given, but there is no reference to a comparison with a colour chart, only the colour obtained.

Mark awarded for (f) = 1 out of 2

8 The equation has been balanced correctly.

Mark awarded for (g) = 2 out of 2

Total mark awarded = 9 out of 11

How the candidate could have improved the answer

(c) The candidate realised that energy was being lost but muddled up endothermic and exothermic reactions. The candidate could have gained the mark by realising that a downward arrow means heat given out.

(e) The mark was given but a better answer would have included that the red litmus paper was damp.

(f) The answer could have been improved by stating that you would measure the pH using comparison with a colour chart.

Example Candidate Response – Question 6, Middle

6 Ammonia is manufactured by the reaction of nitrogen with hydrogen in the presence of a catalyst.

(a) What is the purpose of a catalyst?

Speed up the reaction and remains unchanged 1 [1]

(b) The reaction is reversible.

Complete the equation below by adding the sign for a reversible reaction.

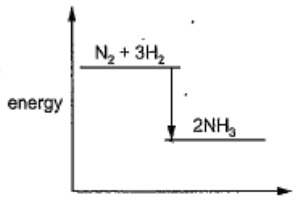
$N_2 + 3H_2$ ⇌ $2NH_3$ 2

[1]

(c) The energy level diagram for this reaction is shown.

Is this reaction exothermic or endothermic?

Give a reason for your answer.



Endothermic

The energy is stored. 3 [1]

Examiner comments

1 Correct.

Mark awarded for (a) = 1 out of 1

2 The symbol for a reversible reaction is correct.

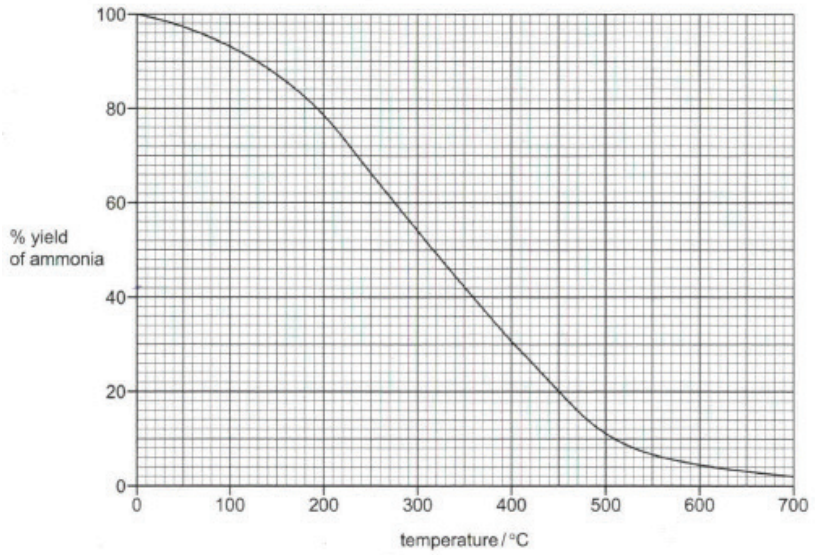
Mark awarded for (b) = 1 out of 1

3 The energy decreases from reactants to products and so heat is given out and the reaction is exothermic (not endothermic).

Mark awarded for (c) = 0 out of 1

Example Candidate Response – Question 6, Middle

(d) The graph shows how the percentage yield of ammonia changes with temperature when the pressure is kept constant.



(i) Describe how the percentage yield of ammonia changes with temperature.

Decreases 4 [1]

(ii) Determine the percentage yield of ammonia at 350 °C.

42 % 5 [1]

(e) Describe a test for ammonia.

test 6 acid

result ammonia gas 7 [2]

(f) Ammonia is a weak base.

Describe how you would measure the pH of an aqueous solution of a weak base using Universal Indicator.

By adding the universal indicator in to the aqueous 8 solution. If the pH ~~is~~ between 9-11 then it is a weak base. [2] 9

(g) Complete the chemical equation for the reaction of ammonia with chlorine.

2 NH_3 + 3 Cl_2 → N_2 + 3 HCl 10 [2]

Examiner comments

4 'Decreases' alone is insufficient. No mention has been made as to whether the yield increases or decreases as temperature increases.

5 Correct.

Mark awarded for (d) = 1 out of 2

6 Adding an acid is not accurate enough. The mark could have been given for 'concentrated hydrochloric acid'.

7 The result should be a description, e.g. what you see, rather than the name of a compound.

Mark awarded for (e) = 0 out of 2

8 The addition of the indicator to the solution is mentioned.

9 A description of how you find the pH is required here (compare with a colour chart), not just stating the pH value.

Mark awarded for (f) = 1 out of 2

10 NH_3 is correctly balanced but HCl is not.

Mark awarded for (g) = 1 out of 2

Total mark awarded = 5 out of 11

How the candidate could have improved the answer

(c) The candidate gave a vague answer and muddled up endothermic and exothermic reactions. They could have gained the mark by realising that a downward arrow means heat given out.

(d) (i) The mark could have been obtained by writing about both yield and temperature. For example, 'yield decreases as temperature increases'.

(e) The command word 'describe' means that candidates should give the reagent used to test for ammonia as well as what they would see as a result of using it. The marks could have been improved by describing an observation instead of just giving the name of a compound (ammonia gas).

(f) The second mark could have been obtained by stating that you would measure the pH using comparison with a colour chart, rather than just quoting an alkaline pH value.

(g) The chlorine was not balanced correctly. The correct balance could have been obtained by noting that there are two chlorine atoms in one chlorine molecule, so 3 x 2 = 6 to balance the HC*l*.

Example Candidate Response – Question 6, Low

6 Ammonia is manufactured by the reaction of nitrogen with hydrogen in the presence of a catalyst.

(a) What is the purpose of a catalyst?

Slow down a reaction [1] 1

(b) The reaction is reversible.

Complete the equation below by adding the sign for a reversible reaction.

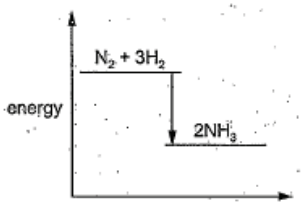
$N_2 + 3H_2$ ⇌ $2NH_3$ 2

[1]

(c) The energy level diagram for this reaction is shown.

Is this reaction exothermic or endothermic?

Give a reason for your answer.



endothermic because the energy is decreasing 3 [1]

Examiner comments

1 Catalysts speed up a reaction. A substance which slows a reaction is called an inhibitor.

Mark awarded for (a) = 0 out of 1

2 This is sufficient to be awarded a mark.

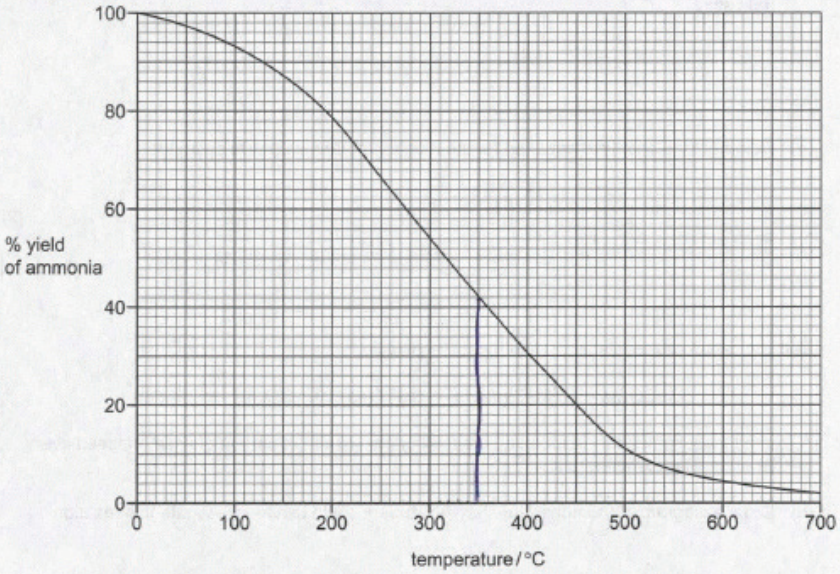
Mark awarded for (b) = 1 out of 1

3 Although the reason 'energy is decreasing' is correct, this means that energy is being given out (exothermic).

Mark awarded for (c) = 0 out of 1

Example Candidate Response – Question 6, Low

(d) The graph shows how the percentage yield of ammonia changes with temperature when the pressure is kept constant.



(i) Describe how the percentage yield of ammonia changes with temperature.

low temps = more ammonia 4 [1]

(ii) Determine the percentage yield of ammonia at 350 °C.

41% 5 [1]

(e) Describe a test for ammonia.

test the percentage of ammonium in high temperatures

result higher the temperatures the less the ammonium 6 [2]

(f) Ammonia is a weak base.

Describe how you would measure the pH of an aqueous solution of a weak base using Universal Indicator.

You use a PH strip 7

[2]

(g) Complete the chemical equation for the reaction of ammonia with chlorine.

.....NH_3 + $3Cl_2$ → N_2 + ...HCl + $2Cl_2$ + N_3 8 [2]

Examiner comments

4 This was given the benefit of the doubt. A better answer would have been 'the lower the temperature, the greater the yield of ammonia'.

5 This value is not accurate enough to gain a mark.

Mark awarded for (d) = 1 out of 2

6 The candidate has referred back to the graph instead of describing a test (damp red litmus) and a result (turns blue).

Mark awarded for (e) = 0 out of 2

7 It is not clear how the pH strip is used here, i.e. dip the (Universal Indicator) strip into the solution.

Mark awarded for (f) = 1 out of 2

8 The dotted lines are intended to show where the number for balance should be written. These have not been used.

Mark awarded for (g) = 1 out of 2

Total marks awarded = 4 out of 11

How the candidate could have improved the answer

(a) The mark could have been gained by knowing that catalysts speed up a reaction. A substance which slows down a reaction is an inhibitor.

(c) The candidate could have gained the mark by realising that a downward arrow means heat given out and therefore the reaction is exothermic.

(d) (i) Although the mark was awarded, the answer could have been improved by writing more accurately, for example, 'yield decreases as temperature increases'.

(e) The candidate referred back to the graph included in the preceding question instead of treating this as a separate question. The answer could have been improved by giving the reagent used to test for ammonia as well as what is seen as a result.

(f) The reference to a pH strip was too vague. The answer could have been improved by describing dipping the strip into the solution and comparing the strip with a colour chart.

(g) The answer could have been improved by counting the numbers of each type of atom on each side of the equation and then making them equal. Using the dotted lines provided for this would also have made the answer clearer.

Common mistakes candidates made in this question

(a) The commonest error was to mistake a catalyst for another type of chemical compound.

(b) The commonest errors were to write either a backward arrow or a single forward arrow (sometimes wavy).

(c) Many candidates thought incorrectly that the reaction was endothermic (perhaps because the arrow goes downwards) even though they went on to comment that the energy of the products is less than that of the reactants. Others did not refer to the diagram at all.

(d) (i) Some candidates stated incorrectly that increasing the temperature increases the rate. Others omitted any reference to the temperature altogether.

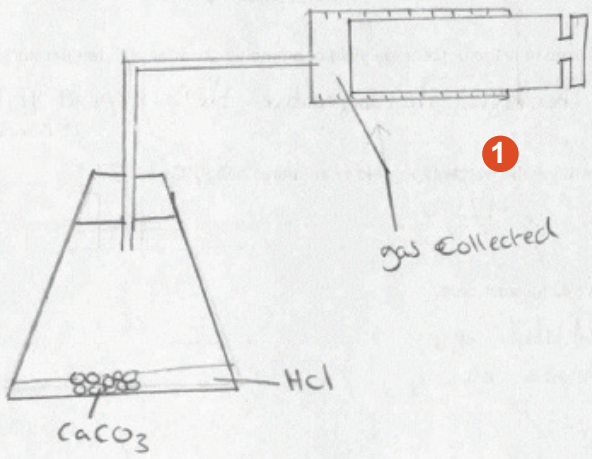
(d) (ii) The commonest error was to suggest 41%, based on a misreading of the graph.

(e) Many candidates did not remember the test for ammonia. Many gave incorrect test reagents, including copper sulfate, bromine water or silver nitrate. Others suggested smelling the fumes, which is not a good idea for safety reasons.

(f) Many candidates suggested using other indicators, despite the fact that the instructions mentioned the Universal Indicator. The commonest error was failure to mention comparison with a colour chart or pH chart.

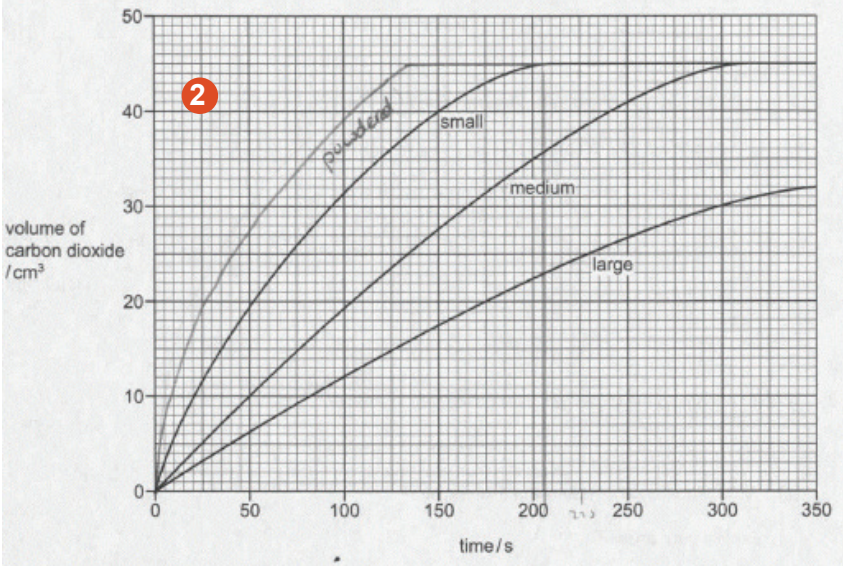
(g) The balance of the HCl was often incorrect, common errors being 2HCl or 3HCl.

Question 7

Example Candidate Response – Question 7, High	Examiner comments
7 Calcium carbonate reacts with dilute hydrochloric acid. $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$ A student investigated this reaction by measuring the volume of carbon dioxide released every minute at constant temperature. (a) Draw a diagram of the apparatus that the student could use to investigate this reaction.  [2]	1 This is a good diagram. Although the syringe is not labelled, it is clearly a gas syringe and has graduation marks. Mark awarded for (a) = 2 out of 2

Example Candidate Response – Question 7, High

(b) The graph shows the results of this reaction using three samples of calcium carbonate of the same mass: large pieces, medium-sized pieces and small pieces.



(i) Which sample, large, medium or small pieces, gave the fastest initial rate of reaction?

Use the graph to explain your answer.

Small is the fastest then medium then large, ~~because~~ it is fast because it has a larger surface area. [2]

(ii) The experiment was repeated using powdered calcium carbonate of the same mass. Draw a line **on the grid above** to show how the volume of carbon dioxide changes with time for this experiment. [2]

(iii) At what time was the reaction just complete when small pieces of calcium carbonate were used?

~~2280~~ 205 s [1]

(c) When calcium carbonate is heated strongly, calcium oxide is formed.

(i) Give **one** use of calcium oxide.

neutralise acidic lakes [1]

(ii) What type of oxide is calcium oxide?

Explain your answer.

Calcium oxide is lime it is one type ~~of~~ oxide [2]

Examiner comments

2 The line is steeper and ends up at 45 cm^3.

3 There is no reference to the graph here, just a theoretical explanation.

4 This is within the range allowed.

Mark awarded for (b) = 4 out of 5

5 A suitable example is given here.

6 Type of oxide not identified and no explanation given.

Mark awarded for (c) = 1 out of 3

Total mark awarded = 7 out of 10

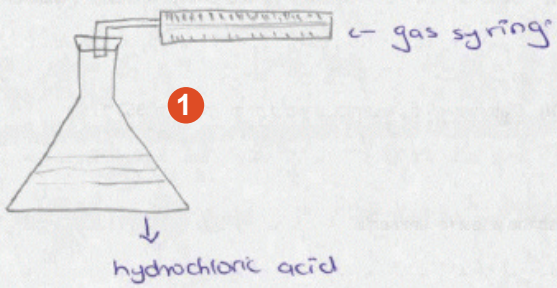
How the candidate could have improved the answer

(a) Both marks were given here, although the answer could have been improved by labelling the gas syringe.

(b) (i) The answer could have been improved by referring to the gradient of the graph and not using theory.

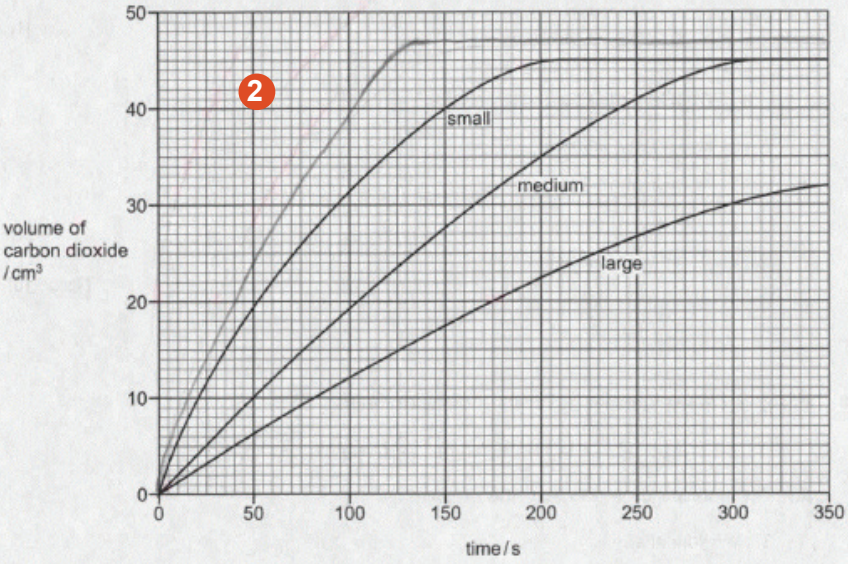
(b) (ii) The marks were given but the line could have been improved by making it more curved towards the end.

(c) (ii) The answer could have been improved by realising that the wording in the question 'type of oxide' refers to either acidic or basic oxides.

Example Candidate Response – Question 7, Middle	Examiner comments
7 Calcium carbonate reacts with dilute hydrochloric acid. $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$ A student investigated this reaction by measuring the volume of carbon dioxide released every minute at constant temperature. **(a)** Draw a diagram of the apparatus that the student could use to investigate this reaction.  [2]	1 The gas syringe is labelled and there are graduation marks. There are no gaps in the apparatus. Both marks were given, although the drawing could have been improved. Both marks were given although the drawing could have been improved by not showing the stopper cutting across the delivery tube. Mark awarded for (a) = 2 out of 2

Example Candidate Response – Question 7, Middle	Examiner comments

(b) The graph shows the results of this reaction using three samples of calcium carbonate of the same mass: large pieces, medium-sized pieces and small pieces.



(i) Which sample, large, medium or small pieces, gave the fastest initial rate of reaction?

Use the graph to explain your answer.

Small

- because it becomes constant in 200s other than the others two [2]

(ii) The experiment was repeated using powdered calcium carbonate of the same mass. Draw a line **on the grid above** to show how the volume of carbon dioxide changes with time for this experiment. [2]

(iii) At what time was the reaction just complete when small pieces of calcium carbonate were used?

200 seconds [1]

(c) When calcium carbonate is heated strongly, calcium oxide is formed.

(i) Give **one** use of calcium oxide.

as an ore [1]

(ii) What type of oxide is calcium oxide?

Explain your answer.

oxygen

[2]

2 The line starts off steeper but the horizontal part of the line should be at the same value as the small and medium pieces because the same mass of calcium carbonate was used.

3 The small pieces have been identified but the reason has not been explained well enough. The mark would have been given if an answer such as 'it becomes a constant volume before the others' had been written.

4 At 200 seconds the reaction has not quite finished.

Mark awarded for (b) = 2 out of 5

5 A specific use is needed here, such as 'for neutralising acidic lakes'.

6 For the core Paper, the type of oxide should be either *acidic* or *basic*.

Mark awarded for (c) = 0 out of 3

Total mark awarded = 4 out of 10

How the candidate could have improved the answer

(a) Both marks were given but the answer could have been improved by not drawing lines across the delivery tube.

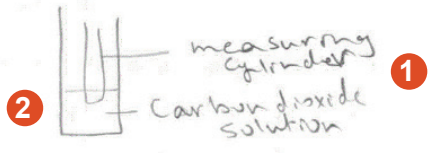
(b) (i) The answer could have been improved by stating that the small marble chips finished reacting *before* the others.

(b) (ii) The answer could have been improved by drawing the line so that the final volume was at 45 cm^3. The hint for this can be found in the stem of the question where it is stated that the same mass was used.

(b) (iii) The mark could have been gained after a closer look at the curve to see where it first hits the 45 cm^3 level.

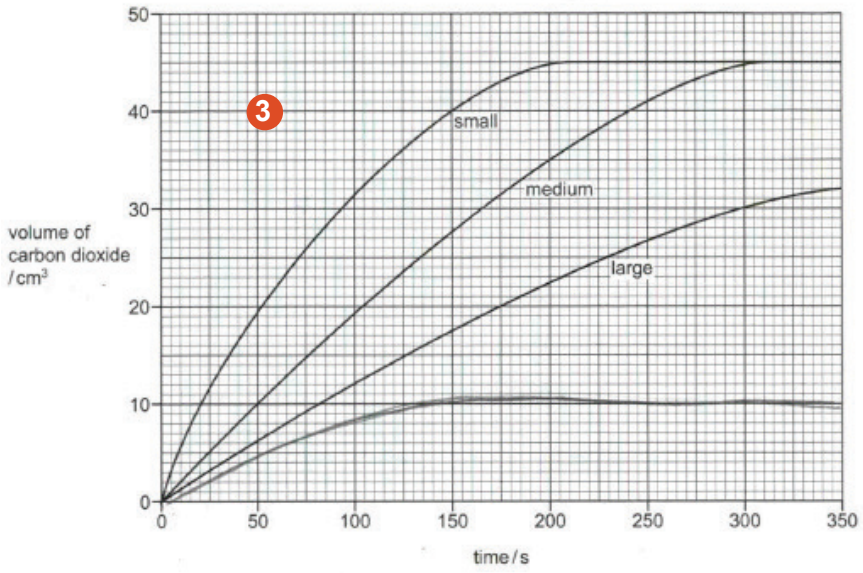
(c) (i) The mark could have been gained by referring to the uses of the various compounds named in the syllabus.

(c) (ii) The answer could have been improved by realising that the wording in the question 'type of oxide' refers to either *acidic* or *basic* oxides.

Example Candidate Response – Question 7, Low	Examiner comments
7 Calcium carbonate reacts with dilute hydrochloric acid. $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$ A student investigated this reaction by measuring the volume of carbon dioxide released every minute at constant temperature. **(a)** Draw a diagram of the apparatus that the student could use to investigate this reaction.  2 1	1 A measuring cylinder has been suggested but there is no tube leading to a flask. 2 Gas could escape from the beaker here. Mark awarded for (a) = 0 out of 2

Example Candidate Response – Question 7, Low

(b) The graph shows the results of this reaction using three samples of calcium carbonate of the same mass: large pieces, medium-sized pieces and small pieces.



(i) Which sample, large, medium or small pieces, gave the fastest initial rate of reaction?

Use the graph to explain your answer.

small, because as volume ~~i~~ time
because if ~~volume~~ time increased the volume increased [2]

(ii) The experiment was repeated using powdered calcium carbonate of the same mass. Draw a line **on the grid above** to show how the volume of carbon dioxide changes with time for this experiment. [2]

(iii) At what time was the reaction just complete when small pieces of calcium carbonate were used?

350 /s [1]

(c) When calcium carbonate is heated strongly, calcium oxide is formed.

(i) Give **one** use of calcium oxide.

& Indactor [1]

(ii) What type of oxide is calcium oxide?

Explain your answer.

~~when~~ oxygen ~~reacts~~ becomes it form calcium oxide [2]

Examiner comments

3 Small pieces should react faster so the gradient (slope) should be steeper than the others and end up at 45 cm^3.

4 The small pieces have been identified correctly but the gradient (slope) of the graph has not been used to explain this.

5 The highest value of time on the graph has been used instead of the time when the horizontal line starts.

Mark awarded for (b) =
1 out of 5

6 A use such as 'neutralising acidic lakes' is required here.

7 For the core Paper, the type of oxide should be either *acidic* or *basic*.

Mark awarded for (c) =
0 out of 3

Total mark awarded =
1 out of 10

How the candidate could have improved the answer

(a) The answer could have been improved by using the measuring cylinder to collect the gas via a delivery tube and making the apparatus airtight (no spaces for the gas to escape).

(b) (i) The answer could have been improved by referring to the gradient of the graph, rather than making a general comment relating increase in time to increase in volume.

(b) (ii) The answer could have been improved by drawing the line so that the final volume was at 45 cm^3. A hint for this can be found in the stem of the question where it is stated that the same mass was used.

(b) (iii) The answer could have been improved by realising that the point at which the reaction finishes is where the line *starts* being horizontal, not at the last point on the graph.

(c) (i) The mark could have been gained by referring to the uses of the various compounds named in the syllabus.

(c) (ii) The answer could have been improved by realising that the wording in the question 'type of oxide' refers to either *acidic* or *basic* oxides.

Common mistakes candidates made in this question

(a) Many candidates made errors in drawing the diagram, showing unidentifiable or incorrect apparatus or gaps which would mean that gas could escape. Examiners often found it difficult to distinguish a drawing of a gas syringe from one of a measuring cylinder, and graduation marks were often missing. Many candidates did not label the apparatus.

(b) (i) Common errors were stating medium or large pieces of calcium carbonate or that less carbon dioxide was produced by small pieces. Some candidates wrote about particle theory instead of referring to the graph, as requested in the question.

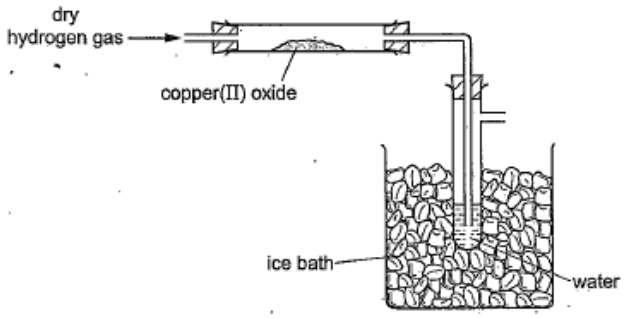
(b) (ii) Many candidates lost a mark because they either finished the line on the graph too far above the 45 cm^3 level or made the line level off after 200 seconds. Another common error was to start the line above the origin (0-0).

(b) (iii) Many did not look closely enough at the curve to see where it first hit the 45 cm^3 level and so suggested the incorrect answer of 200 seconds.

(c) (i) The commonest incorrect answers involved food or drink as a result of confusing the common name of calcium oxide (lime) with the fruit. There were many inaccurate answers such as 'making limestone' or 'for construction'. 'Making iron' was not accepted because calcium carbonate is put into a blast furnace, not calcium oxide.

(c) (ii) Although many candidates realised that calcium oxide is a metal oxide, few realised that the type of oxide is a *basic* oxide. The commonest error was to suggest that it is an *acidic* oxide.

Question 8

Example Candidate Response – Question 8, High	Examiner comments
8 A teacher passed hydrogen gas over hot copper(II) oxide. $CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(g)$ (a) Which substance is reduced in this reaction? Explain your answer. CuO because is lost Oxygen. 1 [2] (b) The diagram shows the apparatus used.  The hydrogen was passed over the hot copper(II) oxide until the reaction was complete. (i) As the experiment proceeds, suggest what happens to the mass of copper(II) oxide. the mass of the copper (II) oxide will decrease [1] 2 (ii) Suggest why electrical heating is used in this experiment and **not** a Bunsen burner. So that heat is given because electrical [1] heating gives heat evenly bunsenburner gives only one 3 (iii) Describe the chemical test for the presence of water. place. test Anhydrous Copper (II) Sulphate result white to blue 4 [2] [Total: 6]	1 CuO correctly identified here, as well as the loss of oxygen from the compound. Mark awarded for (a) = 2 out of 2 2 Correct. 3 Although the candidate suggests a possible idea, the hydrogen in the diagram has not been mentioned. 4 A suitable test reagent has been added and the correct result has been given. Mark awarded for (b) = 3 out of 4 **Total marks awarded = 5 out of 6**

How the candidate could have improved the answer

(a) This was an example of a good concise answer which gave the correct compound in the equation.

(b) (ii) The candidate made a reasonable general suggestion but without considering the information in the diagram. The mark could have been gained by noting the presence of hydrogen in the diagram and then referring to its flammable nature.

(b) (iii) This is an example of a good concise answer which gave the correct compound and the correct result.

Example Candidate Response – Question 8, Middle

8 A teacher passed hydrogen gas over hot copper(II) oxide.

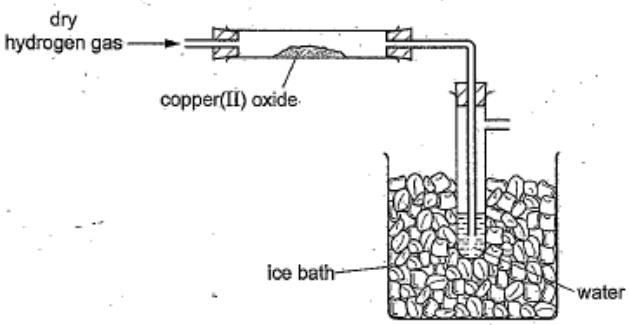
$$CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(g)$$

(a) Which substance is reduced in this reaction?

Explain your answer.

The copper (1) is reduced because it has ~~lose~~ lost the oxygen to Hydrogen which makes Hydrogen ~~be~~ ~~reduces~~ oxidised (2) [2]

(b) The diagram shows the apparatus used.



The hydrogen was passed over the hot copper(II) oxide until the reaction was complete.

(i) As the experiment proceeds, suggest what happens to the mass of copper(II) oxide.

its mass becomes less because it is ~~losing~~ as being reduced. [1] (3)

(ii) Suggest why electrical heating is used in this experiment and **not** a Bunsen burner.

because with electrical heating the ~~heat~~ temperature can be controlled were as the temperature of a bunsen burner can't. (4) [1]

(iii) Describe the chemical test for the presence of water. (5)

test get copper (II) crystals and add a solution to it

result if the crystals become blue then water is present. (6) [2]

[Total: 6]

Examiner comments

1 Copper has been selected rather than copper oxide.

2 Loss of oxygen has been identified correctly.

Mark awarded for (a) = 1 out of 2

3 Correct.

4 Although the candidate suggests a possible idea, the hydrogen in the diagram has not been mentioned.

5 'Copper(II) crystals' is insufficient because this could refer to compounds such as copper oxide or copper carbonate, which would not work.

6 The second mark is dependent on the correct test reagent. Since the test reagent is incorrect, no mark has been given.

Mark awarded for (b) = 1 out of 4

Total mark awarded = 2 out of 6

How the candidate could have improved the answer

(a) The answer could have been improved by stating that copper oxide loses oxygen, not copper.

(b) (ii) The candidate made a reasonable general suggestion but without considering the information in the diagram. The mark could have been gained by noting the presence of hydrogen in the diagram and then referring to its flammable nature.

(b) (iii) This answer could have been improved by giving the name of a suitable anhydrous copper(II) compound. The second mark was not given because it depended on the correct compound being present.

Example Candidate Response – Question 8, Low	Examiner comments

8 A teacher passed hydrogen gas over hot copper(II) oxide.

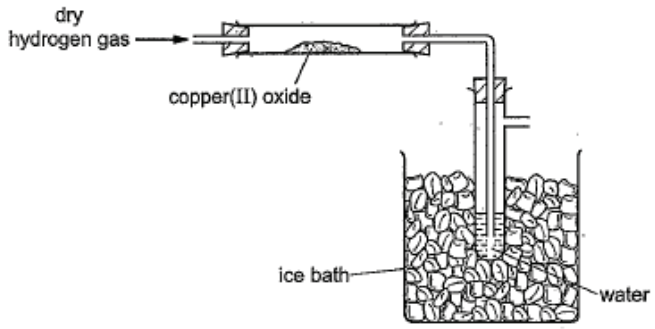
$$CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(g)$$

(a) Which substance is reduced in this reaction?

Explain your answer.

water (l) steam $H_2O(g)$ the g means gas 1 [2]

(b) The diagram shows the apparatus used.



The hydrogen was passed over the hot copper(II) oxide until the reaction was complete.

(i) As the experiment proceeds, suggest what happens to the mass of copper(II) oxide.

decreases 3 [1]

(ii) Suggest why electrical heating is used in this experiment and **not** a Bunsen burner.

Flame electrical heating is more 4 [1]
Accurate

(iii) Describe the chemical test for the presence of water.

test PH Scale universal indicator

result Should be green-ish 5 [2]

1 Copper oxide has not been identified.

Mark awarded for (a) =
0 out of 2

3 Correct.

4 Although the candidate suggests a possible idea, the hydrogen in the diagram has not been mentioned.

5 The correct reagent is anhydrous copper(II) sulfate or anhydrous cobalt (II) chloride.

Mark awarded for (b) =
1 out of 4

Total marks awarded =
1 out of 6

How the candidate could have improved the answer

(a) The answer could have been improved by identifying copper oxide and stating that this loses oxygen, rather than referring to water being formed.

(b) (ii) The candidate made a general suggestion without considering the information in the diagram. The mark could have been gained by noting the presence of hydrogen in the diagram and then referring to its flammable nature.

(b) (iii) The answer could have been improved by giving the name of a suitable anhydrous copper(II) compound. The fact that the Universal Indicator is green at pH 7 does not mean that the solution is water.

Common mistakes candidates made in this question

(a) A common error was to suggest that copper, rather than copper oxide, was reduced, with reference to copper on the right-hand side of the equation.

(b) (i) The most common error was to suggest that the mass increases, presumably because the candidates thought that hydrogen was being added, rather than this being a reduction reaction which removes the oxygen from the copper oxide.

(b) (ii) Many candidates did not refer to the flammable nature of hydrogen and made incorrect statements about the gas coming from the Bunsen burner.

(b) (iii) Many used an incorrect test reagent. Those who gave the correct reagent, copper(II) sulfate or cobalt(II) chloride, often omitted the essential words ‘anhydrous’ or ‘white’ (or ‘pink’ cobalt(II) chloride). The colour changes were often incorrect. For example, copper sulfate goes pink or white.

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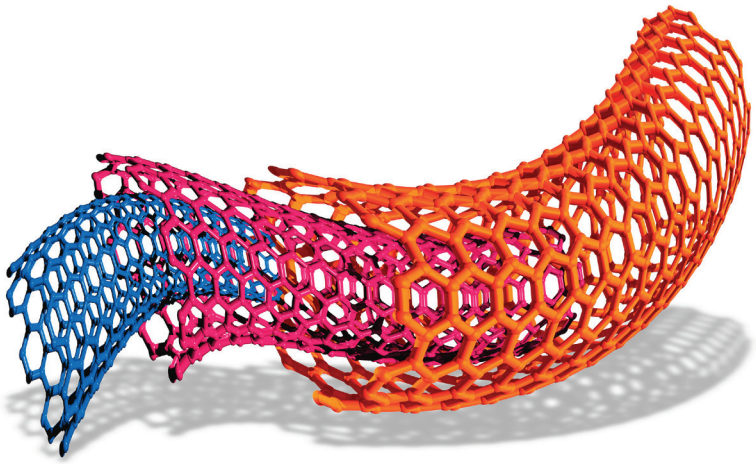
Example Candidate Responses
Paper 4

Cambridge IGCSE™
Chemistry 0620



Version 2.0

Cambridge Pathway

In order to help us develop the highest quality resources, we are undertaking a continuous programme of review; not only to measure the success of our resources but also to highlight areas for improvement and to identify new development needs.

We invite you to complete our survey by visiting the website below. Your comments on the quality and relevance of our resources are very important to us.

www.surveymonkey.co.uk/r/GL6ZNJB

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www.cambridgeinternational.org/cambridge-for/teachers/teacherconsultants/

Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching IGCSE Chemistry (0620), and to show how different levels of candidates' performance (high, middle and low) relate to the subject's curriculum and assessment objectives.

In this booklet candidate responses have been chosen to exemplify a range of answers. Each response is accompanied by a brief commentary explaining the strengths and weaknesses of the answers.

For each question, response is annotated with clear explanation of where and why marks were awarded or omitted. This, in turn, is followed by examiner comments on how the answer could have been improved. In this way it is possible for you to understand what candidates have done to gain their marks and what they will have to do to improve their marks. At the end there is a list of common mistakes candidates made in their answers for each question.

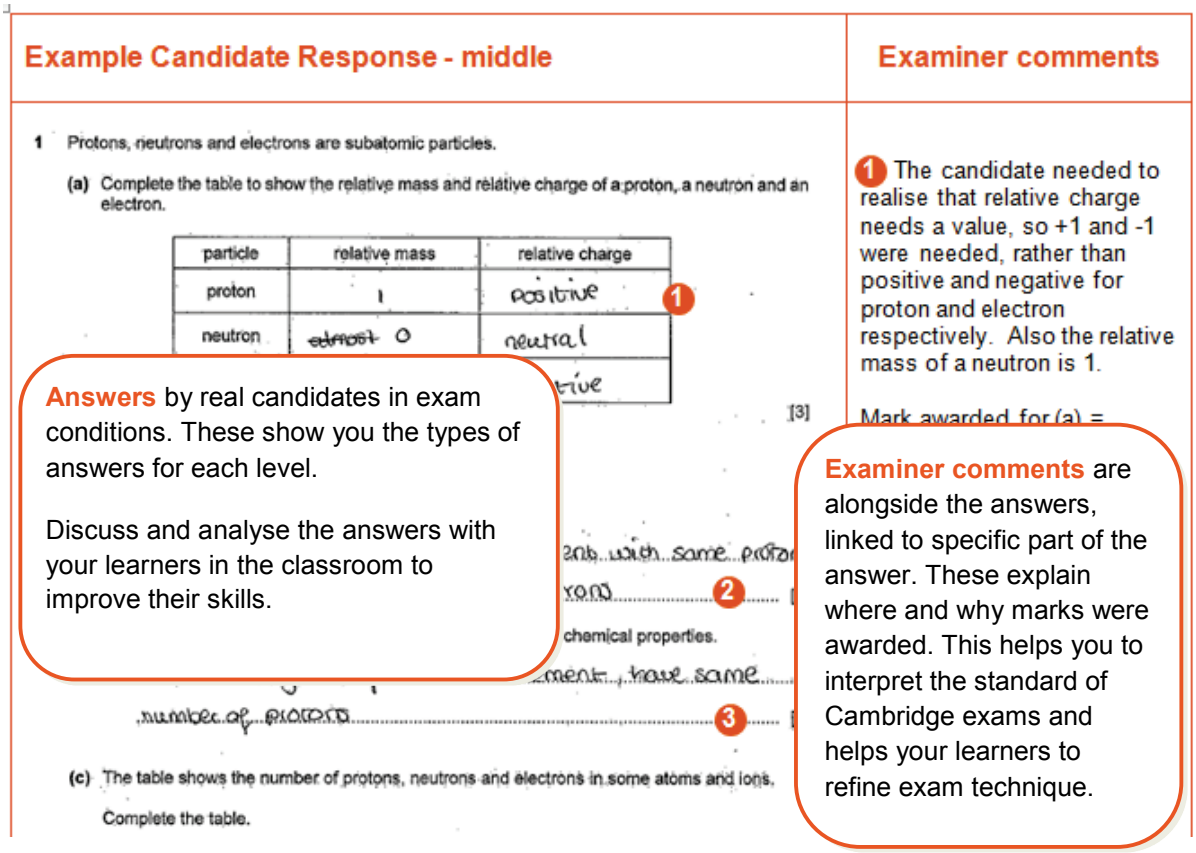
This document provides illustrative examples of candidate work. These help teachers to assess the standard required to achieve marks, beyond the guidance of the mark scheme. Some question types where the answer is clear from the mark scheme, such as short answers and multiple choice, have therefore been omitted.

The questions, mark schemes and pre-release material used here are available to download from the School Support Hub. These files are:

Question Paper 31, June 2016	
Question paper	0620_s16_qp_31.pdf
Mark scheme	0620_s16_ms_31.pdf
Question Paper 41, June 2016	
Question paper	0620_s16_qp_41.pdf
Mark scheme	0620_s16_ms_41.pdf
Question Paper 61, June 2016	
Question paper	0620_s16_qp_61.pdf
Mark scheme	0620_s16_ms_61.pdf

Other past papers, Examiner Reports and other teacher support materials are available on the School Support Hub at www.cambridgeinternational.org/support

How to use this booklet



Example Candidate Response - middle

Examiner comments

1 Protons, neutrons and electrons are subatomic particles.

(a) Complete the table to show the relative mass and relative charge of a proton, a neutron and an electron.

particle	relative mass	relative charge
proton	1	positive
neutron	~~almost~~ 0	neutral
		~~-~~tive

[3]

1 The candidate needed to realise that relative charge needs a value, so +1 and -1 were needed, rather than positive and negative for proton and electron respectively. Also the relative mass of a neutron is 1.

Mark awarded for (a) =

...ons with same ...ro...

...ron ... 2

... chemical properties.

...ment ... have same ...

...number of protons ... 3

(c) The table shows the number of protons, neutrons and electrons in some atoms and ions.

Complete the table.

Answers by real candidates in exam conditions. These show you the types of answers for each level.

Discuss and analyse the answers with your learners in the classroom to improve their skills.

Examiner comments are alongside the answers, linked to specific part of the answer. These explain where and why marks were awarded. This helps you to interpret the standard of Cambridge exams and helps your learners to refine exam technique.

How the candidate could have improved the answer

(b) (ii) The candidate needed to realise ... than positive and negative for proton ar...

(c) The candidate failed to include the r...

This explains how the candidate could have improved the answer. This helps you to interpret the standard of Cambridge exams and helps your learners to refine exam technique.

Common mistakes candidates made in this question

(a) Failing to give *relative* masses and *relative* ...

(b) (i) Failing to recall that isotopes are *atoms*.

(b) (ii) Failing to state that it is the number of o...

This describes the common mistakes candidates made in answering each question. This will help your learners to avoid these mistakes at the exam and give them the best chance of achieving a high mark.

Assessment at a glance

All candidates must enter for three papers.

Core candidates take:	Extended candidates take:
Paper 1 45 minutes A multiple-choice paper consisting of 40 items of the four-choice type. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Core syllabus content. This paper will be weighted at 30% of the final total mark.	**Paper 2** 45 minutes A multiple-choice paper consisting of 40 items of the four-choice type. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Extended syllabus content (Core and Supplement). This paper will be weighted at 30% of the final total mark.
and:	**and:**
Paper 3 1 hour 15 minutes A written paper consisting of short-answer and structured questions. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Core syllabus content. 80 marks This paper will be weighted at 50% of the final total mark.	**Paper 4** 1 hour 15 minutes A written paper consisting of short-answer and structured questions. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Extended syllabus content (Core and Supplement). 80 marks This paper will be weighted at 50% of the final total mark.

All candidates take	
either:	**or:**
Paper 5 1 hour 15 minutes Practical Test This paper will test assessment objective AO3. Questions will be based on the experimental skills in Section 7. The paper is structured to assess grade ranges A*–G. 40 marks This paper will be weighted at 20% of the final total mark.	**Paper 6** 1 hour Alternative to Practical This paper will test assessment objective AO3. Questions will be based on the experimental skills in Section 7. The paper is structured to assess grade ranges A*–G. 40 marks This paper will be weighted at 20% of the final total mark.

Teachers are reminded that the latest syllabus is available on our public website at www.cambridgeinternational.org and the School Support Hub at www.cambridgeinternational.org/support

Paper 4 – Theory (Extended)

Question 1

Example Candidate Response – Question 1, High	Examiner comments

1 Protons, neutrons and electrons are subatomic particles.

(a) Complete the table to show the relative mass and relative charge of a proton, a neutron and an electron.

particle	relative mass	relative charge
proton	1	+1
neutron	1	0
electron	$\frac{1}{1840}$	-1

[3]

(b) Bromine has two isotopes.

(i) Define the term *isotope*.

Isotopes are atoms of the same element with the same number of protons but different numbers of neutrons [2]

(ii) Explain why the two isotopes of bromine have the same chemical properties.

They have the same number of valency electrons so they react the same [2]

(c) The table shows the number of protons, neutrons and electrons in some atoms and ions.

Complete the table.

particle	number of protons	number of neutrons	number of electrons
$^{7}_{3}Li$	3	4	3
$^{34}_{16}S^{2-}$	16	18	18
$^{41}_{19}F^{+}$	19	22	18

[5]

[Total: 12]

Mark awarded for (a) = 3 out of 3

Mark awarded for (b) = 4 out of 4

1 An almost model response to this question, except for 'F' instead of 'K'.

Mark awarded for (c) = 4 out of 5

Total mark awarded = 11 out of 12

How the candidate could have improved the answer

This answer was almost completely correct. In **(c)**, the candidate failed to realise that the element with the atomic number 19 was potassium (K).

Example Candidate Response – Question 1, Middle

1 Protons, neutrons and electrons are subatomic particles.

(a) Complete the table to show the relative mass and relative charge of a proton, a neutron and an electron.

particle	relative mass	relative charge
proton	1	positive
neutron	~~almost~~ 0	neutral
electron	$\frac{1}{1840}$	negative

[3]

(b) Bromine has two isotopes.

(i) Define the term *isotope*.

Isotopes are atom of the same elements with same proton number but different number of neutron [2]

(ii) Explain why the two isotopes of bromine have the same chemical properties.

Because they are of the same element, have same number of protons [2]

(c) The table shows the number of protons, neutrons and electrons in some atoms and ions.

Complete the table.

particle	number of protons	number of neutrons	number of electrons
$^{7}_{3}Li$	3	4	3
$^{34}_{16}S^{2-}$	16	18	18
$^{41}_{19}K^{+}$	19	22	18

[5]

$^{32}_{16}S$ $^{32}_{16}S^{2-}$ # nucleons = P + N

N = nucleon − P

[Total: 12]

Examiner comments

1 The candidate needed to realise that the relative charge needs a value, so +1 and −1 were needed, rather than 'positive' and 'negative' for *proton* and *electron* respectively. Also the relative mass of a neutron is 1.

Mark awarded for (a) = 1 out of 3

2 Correct.

3 A correct explanation would have referred to isotopes of bromine having the same number of outer electrons.

Mark awarded for (b) = 2 out 4

4 The mass number (41) is missing.

Mark awarded for (c) = 4 out 5

Total marks awarded = 7 out of 12

How the candidate could have improved the answer

(a) The candidate needed to realise that the relative charge needs a value, so +1 and −1 were needed, rather than 'positive' and 'negative' for proton and electron respectively. Also the relative mass of a neutron is 1.

(c) The candidate failed to include the mass number of potassium (41).

Example Candidate Response – Question 1, Low

Examiner comments

1 Protons, neutrons and electrons are subatomic particles.

(a) Complete the table to show the relative mass and relative charge of a proton, a neutron and an electron.

particle	relative mass	relative charge
proton	$\frac{1226}{1840}$	neutral
neutron	$\frac{613}{1840}$	+
electron	$\frac{1}{1840}$	−

[3]

(b) Bromine has two isotopes.

(i) Define the term *isotope*.

Different ~~versions~~ ~~on~~ of the same element have different number of neutrons [2]

(ii) Explain why the two isotopes of bromine have the same chemical properties.

Because they are still the same element and they both have the same ~~same~~ number of protons and electrons [2]

(c) The table shows the number of protons, neutrons and electrons in some atoms and ions.

Complete the table.

particle	number of protons	number of neutrons	number of electrons
$^{7}_{3}Li$	3	4	~~7~~ 3
$^{34}_{16}S^{2-}$	16	~~16~~ 16	~~16~~ 16
$^{40}_{18}Ag^{+}$	19	22	18

[5]

[Total: 12]

1 The candidate needed to realise that the relative charge needs a value, so +1 and −1 were needed for *proton* and *electron* respectively. They also needed to know that neutrons have no charge. The relative masses of a proton and a neutron are both 1.

Mark awarded for (a) = 0 out of 3

2 The candidate gives a partial definition of *isotope*. They should have stated that isotopes are 'atoms of the same element' here.

3 The candidate should have explained that isotopes have the same chemical properties because they have the same number of outer electrons.

Mark awarded for (b) = 2 out 4

4 Row 1 is correct
The figures in row 2 should be *18* neutrons and *18* electrons. In row 3 the species required is a positive ion of potassium (K) with a mass number of 41 and an atomic number of 19.

Mark awarded for (c) = 2 out 5

Total mark awarded = 4 out of 12

How the candidate could have improved the answer

(a) The candidate should have given the relative mass of 1 for both particles and to realise that the relative charge needs a value, so +1 and −1 were needed rather than 'positive' and 'negative' for proton and electron respectively. They also needed to know that neutrons have no charge.

(b) (i) The candidate partially defined *isotope*. They needed to state that isotopes are atoms of the same element.

(b) (ii) The candidate should have explained that isotopes have the same chemical properties because they have the same number of outer electrons.

(c) In row 2 of the table, the candidate failed to appreciate that this particular species has 18 neutrons and 18 electrons. In row 3, the candidate failed to appreciate that the species required was a positive ion of potassium (K) with a mass number of 41 and an atomic number of 19.

Common mistakes candidates made in this question

(a) Failing to give *relative* masses and *relative* charges.

(b) (i) Failing to recall that isotopes are *atoms*.

(b) (ii) Failing to state that it is the number of outer electrons which determine chemical properties.

(c) Failing to appreciate that ions will not have an equal number of protons and electrons.

Question 2

Example Candidate Response – Question 2, High	Examiner comments

2 Period 3 contains the elements sodium to argon. This question asks about the chemistry of each of the Period 3 elements or their compounds.

(a) Sodium nitrate is a white crystalline solid. When heated it melts and the following reaction occurs.

$$2NaNO_3(l) \rightarrow 2NaNO_2(l) + O_2(g)$$

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

1 mol : 85g
n : 3.40
$= \frac{3.40}{85} = 0.04$ mols

0.04 ..... mol

- number of moles of O_2 formed,

2 : 1
0.04 : n
$n = \frac{0.04}{2} = 0.02$

0.02 ..... mol

- volume of O_2 formed, in dm^3 (measured at r.t.p.).

1 : 24
0.02 : n
$n = 24 \times 0.04 = 0.48$

0.48 ..... dm^3 [3]

1

(b) Magnesium reacts slowly with warm water to form a base, magnesium hydroxide.

(i) Explain what is meant by the term *base*.

A compound that can react with an acid to give salt. [1] 2

(ii) Write a chemical equation for the reaction between magnesium and warm water.

$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$ 3 ..... [2]

1 Correct.

Mark awarded for (a) = 3 out of 3

2 The answer needed to include the idea of a proton acceptor.

3 Correct.

Mark awarded for (b) = 2 out 3

Example Candidate Response – Question 2, High	Examiner comments

(c) Aluminium oxide is amphoteric. It is insoluble in water.

Describe experiments to show that aluminium oxide is amphoteric.

4

Add aluminium oxide to a few drops of the aqueous sodium hydroxide, a white precipitate will form; add excess sodium hydroxide, solution will be dissolve to give a colorless solution. Aluminium oxide will react with an acid like HCl to form a salt, acting as base. It will redissolve in excess sodium hydroxide solution to form a colourless solution by forming salt of sodium Aluminate while acting as acid. [3]

(d) Silicon(IV) oxide has a giant structure.

(i) Name the type of bonding in silicon(IV) oxide.

Covalent [1]

(ii) Give two **physical** properties of silicon(IV) oxide.

High melting and boiling point

Insoluble in water. 5 [2]

(e) Calcium phosphate is used in fertilisers. The bonding in calcium phosphate is ionic. Calcium phosphate contains the phosphate ion, PO_4^{3-}.

(i) What is ionic bonding?

Bonding between a cation and anion through complete transfer of electrons. Electrostatic forces hold the bonds. 6 [2]

(ii) Deduce the formula of calcium phosphate.

$Ca_3(PO_4)_2$ 7 [1]

4 The candidate mentions reacting aluminium with named acids and bases but does not describe the dissolving of aluminium oxide in acids.

Mark awarded for (c) = 2 out of 3

5 Correct.

Mark awarded for (d) = 3 out of 3

6 The answer scores one mark for giving the oppositely charged ions involved but does not state that these particles attract one another

7 Correct.

Mark awarded for (e) = 2 out 3

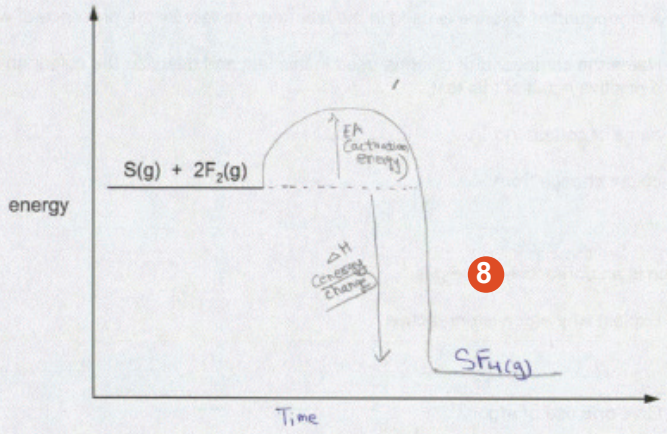
Example Candidate Response – Question 2, High	Examiner comments

(f) Sulfur tetrafluoride, SF_4, can be made by combining gaseous sulfur with fluorine.

$$S(g) + 2F_2(g) \rightarrow SF_4(g)$$

The reaction is exothermic.

(i) Complete the energy level diagram for this reaction. Include an arrow which clearly shows the energy change during the reaction.

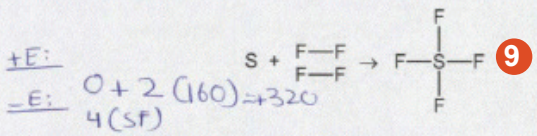


[3]

(ii) During the reaction the amount of energy given out is 780 kJ/mol.

The F–F bond energy is 160 kJ/mol.

Use this information to determine the bond energy, in kJ/mol, of one S–F bond in SF_4.



+E: 0 + 2 (160) = +320

-E: 4 (SF)

320 − 4(x) = −780

x = 275

275 kJ/mol [3]

8 The poorly-drawn enthalpy change arrow loses one mark here. It should have started from a point level with the energy of the reactants and finished at a point level with the energy of the products.

9 Correct.

Mark awarded for (f) = 5 out of 6

Example Candidate Response – Question 2, High	Examiner comments
(g) Chlorine and compounds of chlorine are important in water treatment and in laboratory testing for water. **(i)** Chlorine is added to water to make the water safe to drink. Explain why adding chlorine makes water safe to drink. It kills bacteria in water. [1] **(ii)** A compound of chlorine is used in the laboratory to test for the presence of water. Name the compound of chlorine used in this test and describe the colour change seen in a positive result of this test. name of compound Cobalt chloride colour change from blue to pink 10 [3] **(h)** Argon is an unreactive noble gas. **(i)** Explain why argon is unreactive. It outer shells are complete with electrons. [1] **(ii)** Give **one** use of argon. Filled in filament lamps. [1] 11 [Total: 27]	10 Correct. Mark awarded for (g) = 4 out of 4 11 Correct. Mark awarded for (h) = 2 out of 2 **Total mark awarded = 23 out of 27**

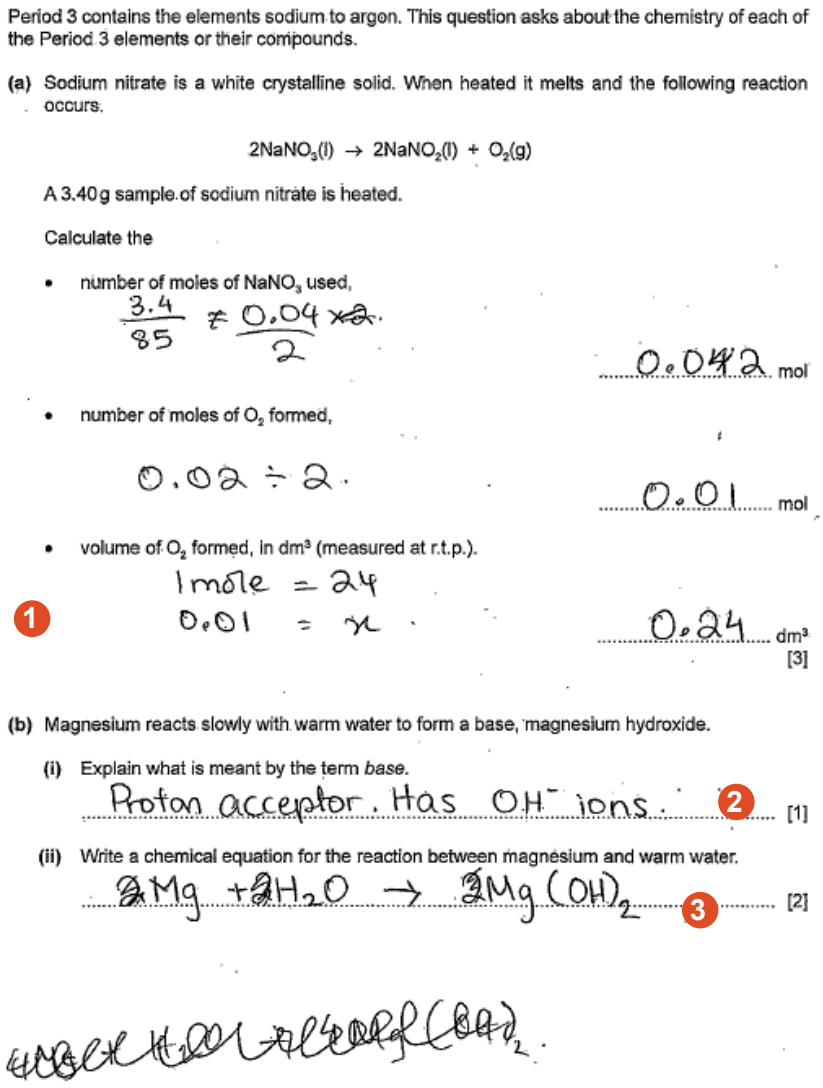
How the candidate could have improved the answer

(b) (i) This needed to include the idea of a proton acceptor.

(c) This included the idea of reacting aluminium with named acids and bases but needed to describe the dissolving of aluminium oxide in acids.

(e) (i) The first mark was scored for giving the oppositely charged ions involved, but the response needed also to state that these particles attract one another.

(f) (i) The only point preventing a score of 3 marks here was the poorly-drawn enthalpy change arrow. The arrow should have started from a point level with the energy of the reactants and finished at a point level with the energy of the products.

Example Candidate Response – Question 2, Middle	Examiner comments
	1 The candidate does not score the first mark but is awarded two marks, as the error is carried forward. Mark awarded for (a) = 2 out of 3 2 Correct. 3 The first mark is awarded here, but the candidate fails to realise that hydrogen is the other product. Mark awarded for (b) = 2 out 3

2 Period 3 contains the elements sodium to argon. This question asks about the chemistry of each of the Period 3 elements or their compounds.

(a) Sodium nitrate is a white crystalline solid. When heated it melts and the following reaction occurs.

$$2NaNO_3(l) \rightarrow 2NaNO_2(l) + O_2(g)$$

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

$\frac{3.4}{85} = \frac{0.04}{2}$ ~~x2~~

0.042 mol

- number of moles of O_2 formed,

0.02 ÷ 2

0.01 mol

- volume of O_2 formed, in dm^3 (measured at r.t.p.).

1 mole = 24

0.01 = x

0.24 dm^3 [3]

(b) Magnesium reacts slowly with warm water to form a base, magnesium hydroxide.

(i) Explain what is meant by the term *base*.

Proton acceptor. Has OH^- ions. [1]

(ii) Write a chemical equation for the reaction between magnesium and warm water.

~~2~~Mg + ~~2~~H_2O → $Mg(OH)_2$ [2]

~~4~~Mg + H_2O → $Mg(OH)_2$.

Example Candidate Response – Question 2, Middle	Examiner comments

(c) Aluminium oxide is amphoteric. It is insoluble in water.

Describe experiments to show that aluminium oxide is amphoteric.

React aluminium oxide with an acid. You will get an aluminum salt and water. React aluminum oxide and base you will get water and salt. 4 [3]

Eg: $Al_2O_3 + H_2SO_4 \rightarrow Al(SO_4)_3 + H_2O$.

(2) $Al_2O_3 + NO_3 \rightarrow Al(NO_3)_3 + H_2$

(d) Silicon(IV) oxide has a giant structure.

(i) Name the type of bonding in silicon(IV) oxide.

Covalent bonding 5 [1]

(ii) Give two **physical** properties of silicon(IV) oxide.

Very hard. and high density. 6 [2]

(e) Calcium phosphate is used in fertilisers. The bonding in calcium phosphate is ionic. Calcium phosphate contains the phosphate ion, PO_4^{3-}.

(i) What is ionic bonding?

Bonding between a metal and non-metal. Cation bonded to anion. 7 [2]

(ii) Deduce the formula of calcium phosphate.

$Ca_3(PO_4)_2$ [1]

4 One mark is awarded for the idea of reacting aluminium oxide with an acid and with a base.

Mark awarded for (c) = 1 out of 3

5 Correct.

6 The answer is awarded one mark for stating that silicon(IV) oxide is hard.

Mark awarded for (d) = 2 out of 3

7 One mark is awarded for giving the oppositely charged ions involved but the candidate fails to state that these particles attract one another.

Mark awarded for (e) = 2 out 3

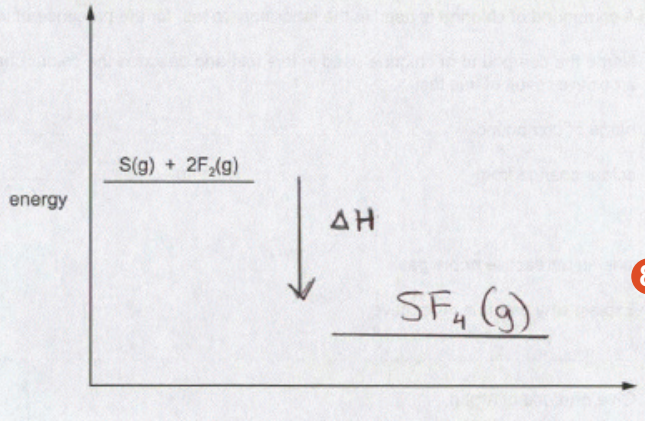
Example Candidate Response – Question 2, Middle	Examiner comments

(f) Sulfur tetrafluoride, SF_4, can be made by combining gaseous sulfur with fluorine.

$$S(g) + 2F_2(g) \rightarrow SF_4(g)$$

The reaction is exothermic.

(i) Complete the energy level diagram for this reaction. Include an arrow which clearly shows the energy change during the reaction.



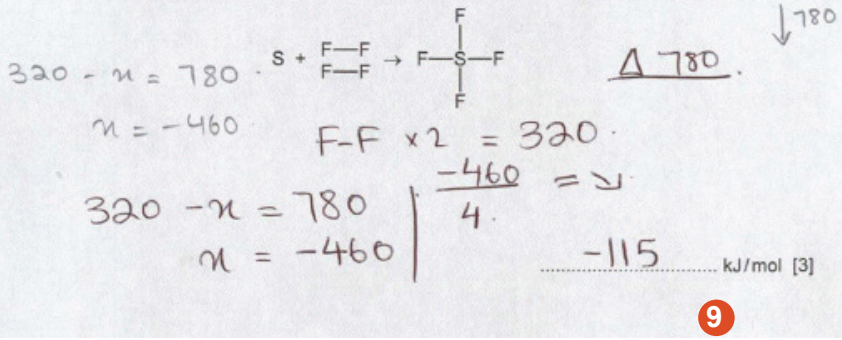
8

[3]

(ii) During the reaction the amount of energy given out is 780 kJ/mol.

The F–F bond energy is 160 kJ/mol.

Use this information to determine the bond energy, in kJ/mol, of one S–F bond in SF_4.



9

8 The poorly-drawn enthalpy change arrow loses a mark here. It should have started from a point level with the energy of the reactants and finished at a point level with the energy of the products.

9 The first mark is awarded for determining the energy needed to break the bonds in $2F_2$ molecules (320 kJ). The third mark is awarded for dividing a processed value (−460 kJ) by 4. The only error was failing to realise that if 320 kJ was put in to break the F_2 bonds and the total energy given out was 780 kJ, then the energy given out when SF_4 formed must have been 1100 kJ. (Note that candidates did not need to know that exothermic changes have negative values and endothermic changes have positive values.)

Mark awarded for (f) =
4 out of 6

Example Candidate Response – Question 2, Middle	Examiner comments
(g) Chlorine and compounds of chlorine are important in water treatment and in laboratory testing for water. **(i)** Chlorine is added to water to make the water safe to drink. Explain why adding chlorine makes water safe to drink. To kill microbes and bacteria. [1] **(ii)** A compound of chlorine is used in the laboratory to test for the presence of water. Name the compound of chlorine used in this test and describe the colour change seen in a positive result of this test. name of compound ~~Ca~~ Cobalt (II) chloride colour change from blue to pink. 10 [3] **(h)** Argon is an unreactive noble gas. **(i)** Explain why argon is unreactive. Has a complete outter electron shell. (8 electrons). [1] **(ii)** Give **one** use of argon. Used in tungsten light bulbs. 11 [1] [Total: 27]	10 Correct. Mark awarded for (g) = 4 out of 4 11 Correct. Mark awarded for (h) = 2 out of 2 **Total marks awarded = 17 out of 27**

How the candidate could have improved the answer

(b) (ii) The first mark was awarded but the candidate needed to state that hydrogen was the other product.

(c) One mark was awarded for reacting aluminium oxide with an acid and with a base. The candidate should have named the acid and the base and should have stated that dissolving would be seen.

(e) (i) The first mark was scored for giving the oppositely charged ions involved but the response needed to state that these particles attract one another.

(f) (i) The only point preventing a score of 3 marks here was the poorly-drawn enthalpy change arrow. It should have started from a point level with the energy of the reactants and finished at a point level with the energy of the products.

(f) (ii) The first mark was awarded for determining the energy needed to break the bonds in $2F_2$ molecules (320 kJ). The third mark was awarded for dividing a processed value (−460 kJ) by 4. The only error was failing to realise that if 320 kJ was put in to break the F_2 bonds and the total energy given out was 780 kJ, then the energy given out when SF_4 formed must have been 1100 kJ. (Note that candidates did not need to know that exothermic changes have negative values and endothermic changes have positive values.)

Example Candidate Response – Question 2, Low	Examiner comments

2 Period 3 contains the elements sodium to argon. This question asks about the chemistry of each of the Period 3 elements or their compounds.

(a) Sodium nitrate is a white crystalline solid. When heated it melts and the following reaction occurs.

$$2NaNO_3(l) \rightarrow 2NaNO_2(l) + O_2(g)$$

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

10 mol

- number of moles of O_2 formed,

6 mol

- volume of O_2 formed, in dm^3 (measured at r.t.p.).

1

48 dm^3 [3]

(b) Magnesium reacts slowly with warm water to form a base, magnesium hydroxide.

(i) Explain what is meant by the term *base*.

it doesn't react 2 [1]

(ii) Write a chemical equation for the reaction between magnesium and warm water.

$2Mg + 2H_2O \rightarrow 2MgH_2O$ 3 [2]

1 The candidate has failed to realise that the number of moles could be found by dividing the mass of sodium nitrate by its relative formula mass (85). Then the stoichiometric ratio from the chemical equation should be used to find the number of moles of oxygen gas. Finally, the number of moles of oxygen should be multiplied by 24 to give the final answer.

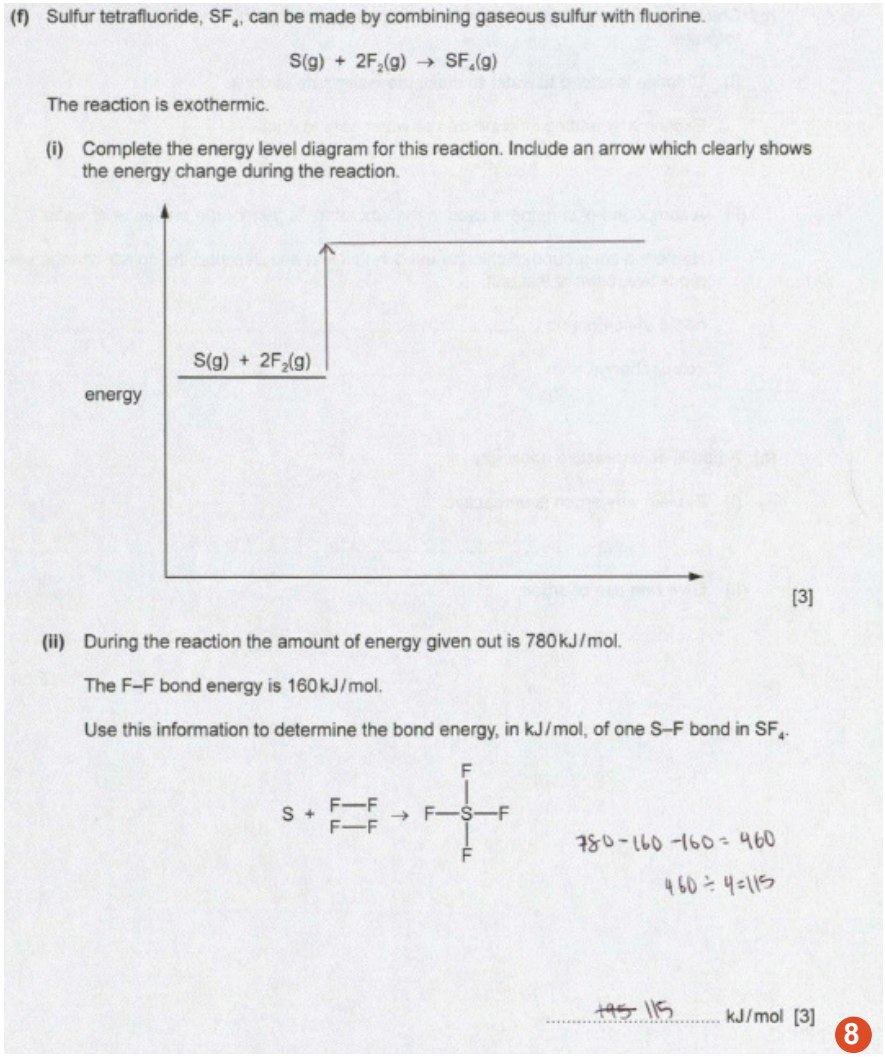
Mark awarded for (a) =
0 out of 3

2 The candidate should have stated that a base was a proton acceptor.

3 The candidate should have written that $Mg(OH)_2$ and H_2 were the products before balancing the equation.

Mark awarded for (b) =
0 out of 3

Example Candidate Response – Question 2, Low	Examiner comments
(c) Aluminium oxide is amphoteric. It is insoluble in water. Describe experiments to show that aluminium oxide is amphoteric. -Try to dissolve it in water 4 [3] **(d)** Silicon(IV) oxide has a giant structure. **(i)** Name the type of bonding in silicon(IV) oxide.<br~~covalent~~ ionic 5 [1] **(ii)** Give two **physical** properties of silicon(IV) oxide. -Shiny -malubal 6 [2] **(e)** Calcium phosphate is used in fertilisers. The bonding in calcium phosphate is ionic. Calcium phosphate contains the phosphate ion, PO_4^{3-}. **(i)** What is ionic bonding? When two ionic compounds bond [2] **(ii)** Deduce the formula of calcium phosphate. $2Ca_3PO_4^{-3}$ [1] 7	4 Clearly the candidate has not read the question carefully. This states that aluminium oxide is insoluble in water. Mark awarded for (c) = 0 out of 3 5 'Covalent' is the correct answer here. 6 These points are not correct Mark awarded for (d) = 0 out of 3 7 No marks awarded here. Mark awarded for (e) = 0 out 3

Example Candidate Response – Question 2, Low	Examiner comments
	8 The first mark is awarded for determining the energy needed to break the bonds in 2 F2 molecules (320 kJ). The third mark is awarded for dividing a processed value (460 kJ) by 4. The only error was failing to realise that if 320 kJ was put in to break the F_2 bonds and the total energy given out was 780 kJ, then the energy given out when SF_4 formed must have been 1100 kJ. (Note that candidates did not need to know that exothermic changes have negative values and endothermic changes have positive values.) Mark awarded for (f) = 3 out of 6

Example Candidate Response – Question 2, Low	Examiner comments
(g) Chlorine and compounds of chlorine are important in water treatment and in laboratory testing for water. **(i)** Chlorine is added to water to make the water safe to drink. Explain why adding chlorine makes water safe to drink. It kills germs 9 [1] **(ii)** A compound of chlorine is used in the laboratory to test for the presence of water. Name the compound of chlorine used in this test and describe the colour change seen in a positive result of this test. name of compound Cl_2 colour change from Green to colourless 10 [3] **(h)** Argon is an unreactive noble gas. **(i)** Explain why argon is unreactive. Because it has a complete outer shell [1] **(ii)** Give **one** use of argon. used it lights 11 [1] [Total: 27]	9 Correct. 10 All answers are incorrect. Mark awarded for (g) = 1 out of 4 11 Correct. Mark awarded for (h) = 2 out of 2 **Total mark awarded = 6 out of 27**

How the candidate could have improved the answer

(a) The candidate failed to realise that the number of moles could be found by dividing the mass of sodium nitrate by its relative formula mass (85). Then the stoichiometric ratio from the chemical equation should be used to find the number of moles of oxygen gas. Finally, the number of moles of oxygen should be multiplied by 24 to give the final answer.

(b) (i) The candidate should have stated that a base was a proton acceptor.

(b) (ii) The candidate should have written that $Mg(OH)_2$ and H_2 were the products before balancing the equation.

(f) (i) The candidate failed to show that the product energy level is below the reactant energy level and should have put the identity of the products on this line.

(f) (ii) The first mark was awarded for determining the energy needed to break the bonds in $2F_2$ molecules (320 kJ). The third mark was awarded for dividing a processed value (−460 kJ) by 4.
The only error was failing to realise that if 320 kJ was put in to break the F_2 bonds and the total energy given out was 780 kJ, then the energy given out when SF_4 formed must have been 1100 kJ. (Note that candidates did not need to know that exothermic changes have negative values and endothermic changes have positive values.)

Common mistakes candidates made in this question

(a) Failing to determine that the relative formula mass of $NaNO_3$ was 85.

(b) (i) Failing to know that the syllabus describes a base as a proton acceptor.

(b) (ii) Assuming that the product was MgO.

(c) Failing to describe the experiment details.

(d) (ii) Giving chemical properties such as ‘acidic’ when physical properties were asked for.

(e) (i) Simply describing how ionic bonds form (by transfer of electrons). Failing to state that the oppositely-charged ions attract one another.

(e) (ii) Leaving the charges on the ions.

(f) (i) Poor drawing of enthalpy change arrows. These arrows should start from a point level with the energy of the reactants and finish at a point level with the energy of the products.

(f) (ii) Failing to realise that if 320 kJ was put in to break the F_2 bonds and the total energy given out was 780 kJ, then the energy given out when SF_4 formed must have been 1100 kJ. (Note that candidates did not need to know that exothermic changes have negative values and endothermic changes have positive values.)

(h) (ii) Stating that Argon is used ‘in filaments in lamps’ instead of ‘in filament lamps’.

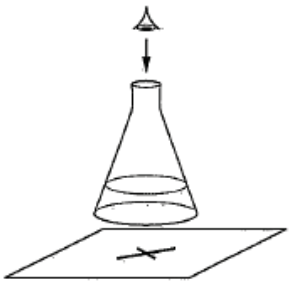
Question 3

Example Candidate Response – Question 3, High	Examiner comments

3 When aqueous sodium thiosulfate and dilute hydrochloric acid are mixed, a precipitate of insoluble sulfur is produced. This makes the mixture difficult to see through.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow S(s) + 2NaCl(aq) + H_2O(l) + SO_2(g)$$

The time taken for the cross to disappear from view is measured.



A student adds the following volumes of aqueous sodium thiosulfate, dilute hydrochloric acid and distilled water to the conical flask.

The time taken for the formation of the precipitate of sulfur to make the cross disappear from view is recorded.

experiment number	volume of sodium thiosulfate /cm³	volume of hydrochloric acid /cm³	volume of distilled water /cm³	time taken for cross to disappear from view/s
1	10	10	40	56
2	20	10	30	28
3	20	10	15	14

(a) State the order in which the aqueous sodium thiosulfate, hydrochloric acid and distilled water should be added to the flask.

~~volume of~~ distilled water then ~~hydrochloric acid~~ then sodium thiosulfate ~~sodium thiosulfate~~ hydrochloric acid [1]

(b) In experiment 3 the student wanted the sodium thiosulfate to be double the concentration used in experiment 2.

(i) Complete the table to show the **volumes** which should be used and the **expected** time taken for the cross to disappear from view in experiment 3. [2]

(ii) Use collision theory to explain why increasing the concentration of sodium thiosulfate would change the rate of reaction.

Increasing the concentration would mean more particles on sodium thiosulfate in that particular volume to react with HCl. There will be more frequent collisions between sodium thiosulfate and HCl and thus rate of reaction would speed up. [2]

(c) The student repeated experiment 1 at a higher temperature.

Use collision theory to explain why the rate of reaction would increase.

At higher temperature, particles gain more kinetic energy and move more faster. There would be more frequent collisions between reactants due to speed and reactants will collide with greater energy. [3]

1 Correct

Mark awarded for (a) = 1 out of 1

2 The candidate shows that doubling the concentration would halve the time, but has failed to see the relevance of keeping the total volume constant.

3 Correct. Both points are adequately explained.

Mark awarded for (b) = 3 out of 4

4 The first two points gain marks, but the candidate needed to state that as the increased temperature caused a higher proportion of collisions to reach activation energy.

Mark awarded for (c) = 2 out of 3

Total mark awarded = 6 out of 8

How the candidate could have improved the answer

3 (b) (i) By keeping the total volume constant.

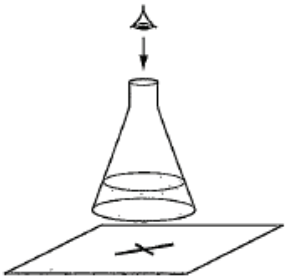
3 (c) The first two points earned marks, but the candidate needed to state that, as a result of the increased temperature, a higher proportion of collisions were able to reach activation energy.

Example Candidate Response – Question 3, Middle

3 When aqueous sodium thiosulfate and dilute hydrochloric acid are mixed, a precipitate of insoluble sulfur is produced. This makes the mixture difficult to see through.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow S(s) + 2NaCl(aq) + H_2O(l) + SO_2(g)$$

The time taken for the cross to disappear from view is measured.



A student adds the following volumes of aqueous sodium thiosulfate, dilute hydrochloric acid and distilled water to the conical flask.

The time taken for the formation of the precipitate of sulfur to make the cross disappear from view is recorded.

experiment number	volume of sodium thiosulfate / cm^3	volume of hydrochloric acid / cm^3	volume of distilled water / cm^3	time taken for cross to disappear from view / s
1	10	10	40	56
2	20	10	30	28
3	40	10	10	14

(a) State the order in which the aqueous sodium thiosulfate, hydrochloric acid and distilled water should be added to the flask.

The sodium thiosulfate and water should be added first, followed by the hydrochloric acid [1]

(b) In experiment 3 the student wanted the sodium thiosulfate to be double the concentration used in experiment 2.

(i) Complete the table to show the **volumes** which should be used and the **expected** time taken for the cross to disappear from view in experiment 3. [2]

(ii) Use collision theory to explain why increasing the concentration of sodium thiosulfate would change the rate of reaction.

When the concentration increases the ~~rate increases~~ ~~because~~ there would be more particles to collide so the reaction would occur faster so the rate would increase [2]

(c) The student repeated experiment 1 at a higher temperature.

Use collision theory to explain why the rate of reaction would increase.

The particles would gain energy when the temperature increases causing them to move faster and collide more frequently and ~~there~~ there would be more successful collisions because more activation energy [3]

Examiner comments

1 Correct.

Mark awarded for (a) = 1 out of 1

2 Correct.

3 The candidate does not refer to the fact that increased concentration results in more particles per unit volume or to the fact that this brings about an increased collision rate between particles

Mark awarded for (b) = 2 out of 4

4 The candidate gains the first two marks here, but does not explain that a higher proportion of collisions would be above activation energy.

Mark awarded for (c) = 2 out of 3

Total mark awarded = 5 out of 8

How the candidate could have improved the answer

(b) (ii) The candidate needed to refer to the fact that increased concentration results in more particles per unit volume and to the fact that this results in an increased collision rate between particles.

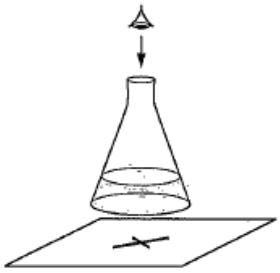
(c) The candidate gained the first two marks but needed to state that, as a result of increased temperature, a higher proportion of collisions were able to reach activation energy.

Example Candidate Response – Question 3, Low

3 When aqueous sodium thiosulfate and dilute hydrochloric acid are mixed, a precipitate of insoluble sulfur is produced. This makes the mixture difficult to see through.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow S(s) + 2NaCl(aq) + H_2O(l) + SO_2(g)$$

The time taken for the cross to disappear from view is measured.



A student adds the following volumes of aqueous sodium thiosulfate, dilute hydrochloric acid and distilled water to the conical flask.

The time taken for the formation of the precipitate of sulfur to make the cross disappear from view is recorded.

experiment number	volume of sodium thiosulfate /cm³	volume of hydrochloric acid /cm³	volume of distilled water /cm³	time taken for cross to disappear from view/s
1	10	10	40	56
2	20	10	30	28
3	40	10	30	14

(a) State the order in which the aqueous sodium thiosulfate, hydrochloric acid and distilled water should be added to the flask.

first distilled water, then hydrochloric acid and then sodium thiosulfate. [1]

(b) In experiment 3 the student wanted the sodium thiosulfate to be double the concentration used in experiment 2.

(i) Complete the table to show the **volumes** which should be used and the **expected** time taken for the cross to disappear from view in experiment 3. [2]

(ii) Use collision theory to explain why increasing the concentration of sodium thiosulfate would change the rate of reaction.

There are more particles of sodium thiosulfate which collide with the other particles, making the reaction go faster. [2]

(c) The student repeated experiment 1 at a higher temperature.

Use collision theory to explain why the rate of reaction would increase.

increasing the heat ~~caus~~ gives the particles more energy so the collide with eachother more often and with greater force, increasing the rate of reaction [3]

Examiner comments

1 Correct.

Mark awarded for (a) =
1 out of 1

2 The candidate shows that doubling the concentration would halve the time but has failed to see the relevance of keeping the total volume constant.

3 The candidate does not refer to the fact that the increased concentration results in more particles per unit volume or to the fact that this results in an increased collision rate between particles.

Mark awarded for (b) =
1 out of 4

4 The candidate explains that the collision rate increases but fails to explain that this is because higher energetic particles move quicker. There is no reference to the fact that a higher proportion of collisions would be above activation energy.

Mark awarded for (c) =
1 out of 3

Total mark awarded =
3 out of 8

How the candidate could have improved the answer

(b) (i) By keeping the total volume constant.

(b) (ii) The candidate did not refer to the fact that an increased concentration results in more particles per unit volume or to the fact that this results in an increased collision rate between particles

(c) The candidate explained that the collision rate increases but failed to explain that this was because higher energetic particles move quicker. There was no reference to the fact that a higher proportion of collisions would be above activation energy.

Common mistakes candidates made in this question

(b) (i) Failing to realise that the total volume of the mixture had to be constant each time.

(b) (ii) Referring to the concentration causing more particles to be present (rather than more particles in a particular volume). Referring to ‘more’ collisions rather than ‘an increased rate of collisions’.

(c) Failing to explain that increasing the temperature leads to a higher proportion of collisions being above activation energy.

Question 4

Example Candidate Response – Question 4, High	Examiner comments

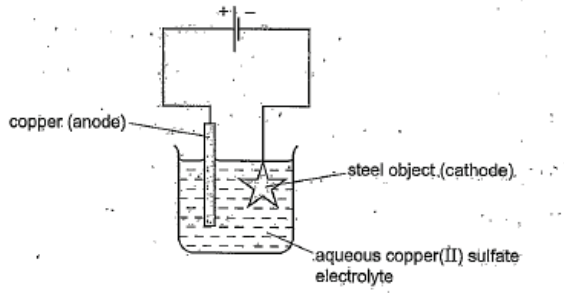
4. Electroplating steel objects with silver involves a three-step process.

step 1 A coating of copper is applied to the object.

step 2 A coating of nickel is applied to the object.

step 3 The coating of silver is applied to the object.

(a) A diagram of the apparatus used for **step 1** is shown.



(i) The chemical process taking place on the surface of the object is

$$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$$

Explain whether this process is oxidation or reduction.

This process is reduction as the Copper is gaining electrons [1]

1 Correct.

(ii) Explain why the concentration of copper ions in the electrolyte remains constant throughout **step 1**.

The copper anode is not inert and therefore loses ions into the electrolyte. This means that although the copper ions are reducing on the surface of the object, they are constantly being replaced with ions from the anode [2]

2 The idea of copper ions being lost from the anode and deposited at the cathode is explained here, but the candidate doesn't state that these processes happen at the same rate.

Mark awarded for (a) = 2 out of 3

(b) Give **two** changes which would be needed in order to coat nickel onto the object in **step 2**.

One would need to change the Copper anode for one made of nickel. One would also need to change the electrolyte for a nickel ionic compound solution, [2]

3 Correct.

(c) Copper, nickel and silver are transition elements.
Typical physical properties of transition elements are a high density and a high melting point.

Give **three** different properties of transition metals which are not typical of other metals.

- They can have variable charges
- They often can be used as catalysts
- They usually form coloured compounds [3]

4 The candidate fails to say that it is the ions which have variable charges.

Mark awarded for (b) = 4 out of 5

Total mark awarded = 6 out of 8

How the candidate could have improved the answer

(a) (ii) The idea of copper ions being lost from the anode and deposited at the cathode was explained, but the candidate also needed to state that these processes happen at the same rate.

(c) The candidate needed to state that it is the ions which have variable charges.

Example Candidate Response – Question 4, Middle	Examiner comments

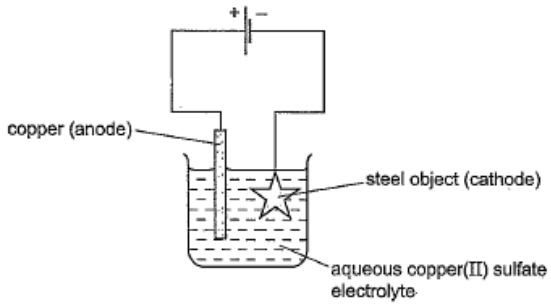
4 Electroplating steel objects with silver involves a three-step process.

step 1 A coating of copper is applied to the object.

step 2 A coating of nickel is applied to the object.

step 3 The coating of silver is applied to the object.

(a) A diagram of the apparatus used for **step 1** is shown.



(i) The chemical process taking place on the surface of the object is

$$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$$

Explain whether this process is oxidation or reduction.

A reduction because ~~it elects~~ when a reduction occurs electrons are being gained [1]

1

(ii) Explain why the concentration of copper ions in the electrolyte remains constant throughout **step 1**.

Because the copper anode replaces the copper ions that were used up [2]

2

(b) Give **two** changes which would be needed in order to coat nickel onto the object in **step 2**.

The electrolyte would needed to be changed to a substance of nickel and the ~~electrode~~ anode would have to be changed as well [2]

3

(c) Copper, nickel and silver are transition elements.
Typical physical properties of transition elements are a high density and a high melting point.

Give **three** different properties of transition metals which are not typical of other metals.

They form coloured ions, they are generally quite unreactive and they ~~conduct electricity and heat~~ well one element has more than 1 form [3]

4

1 Correct.

2 The candidate fails to say that copper ions are lost from the anode and deposited at the cathode and that these processes happen at the same rate.

Mark awarded for (a) = 1 out of 3

3 The candidate fails to state that the anode should be made of nickel.

4 The candidate only gives 'coloured ions' as a property not typical of other metals

Mark awarded for (b) = 2 out of 5

Total mark awarded = 3 out of 8

How the candidate could have improved the answer

(a) (ii) The candidate needed to explain that copper ions are lost from the anode and deposited at the cathode and that these processes happen at the same rate.

(b) The candidate needed to state that the anode should be made of nickel.

Example Candidate Response – Question 4, Low	Examiner comments

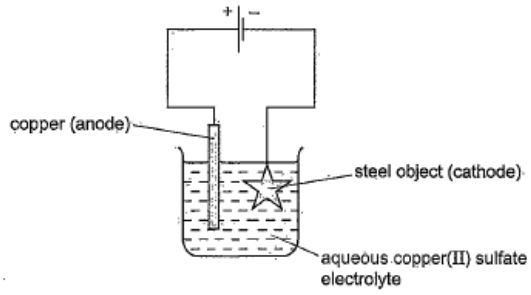
4 Electroplating steel objects with silver involves a three-step process.

step 1 A coating of copper is applied to the object.

step 2 A coating of nickel is applied to the object.

step 3 The coating of silver is applied to the object.

(a) A diagram of the apparatus used for **step 1** is shown.



(i) The chemical process taking place on the surface of the object is

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

Explain whether this process is oxidation or reduction.

The reaction is oxidation because there is a loss of electrons 1 [1]

(ii) Explain why the concentration of copper ions in the electrolyte remains constant throughout **step 1**.

because they are copper(II) and ~~are not attracted~~ are mixed with sulfates 2 [2]

(b) Give **two** changes which would be needed in order to coat nickel onto the object in **step 2**.

A different electrolyte and a ~~different~~ nickle ~~anode~~ at the anode 3 [2]

(c) Copper, nickel and silver are transition elements.
Typical physical properties of transition elements are a high density and a high melting point.

Give **three** different properties of transition metals which are not typical of other metals.

- Malluable
- Ductile
- Shiney 4 [3]

1 Incorrect.

2 Incorrect.

Mark awarded for (a) = 0 out of 3

3 The candidate fails to name a suitable electrolyte.

4 The candidate fails to give properties that are true for transition metals but not for typical metals.

Mark awarded for (b) = 1 out of 5

Total mark awarded = 1 out of 8

How the candidate could have improved the answer

(b) The candidate needed to name a suitable electrolyte.

(c) The candidate needed to give properties that were true for transition metals but not for typical metals.

Common mistakes candidates made in this question

(a) (ii) Common mistake was, not stating that the rate of copper ions forming at the anode was equal to the rate at which they were deposited at the cathode.

(c) Stating properties that were true for both transition metals and for typical metals, e.g. electrical conductivity, or stating differences that were given in the question, e.g. high melting point.

Question 5

Example Candidate Response – Question 5, High	Examiner comments

5 Sulfuric acid is produced by the Contact process. The steps of the Contact process are shown.

starting material **step 1** → sulfur dioxide **step 2** → sulfur trioxide **step 3** → oleum **step 4** → sulfuric acid

(a) Sulfur is a common starting material for the Contact process.

Name a source of sulfur.

USA volcanoes in the USA (1) [1]

(b) Describe **step 2**, giving reaction conditions and a chemical equation. Reference to reaction rate and yield is not required.

$2SO_2 + O_2 \rightarrow 2SO_3$ for this reaction a temperature of 450°C is needed as it is exothermic, a higher temperature would result in grea faster reaction. This reaction is not reverseible. A pressure of 1-2 atmosphere is also needed. ~~A co~~ The catalyst vanadium (v) oxide is also needed. (2) [5]

(c) **Step 3** involves adding sulfur trioxide to concentrated sulfuric acid to form oleum.

Complete the chemical equation for this reaction.

$H_2SO_4 + SO_3 \rightarrow$ $H_2S_2O_7$ (3) [1]

(d) Dilute sulfuric acid is a typical acid.

A student adds excess dilute sulfuric acid to a sample of solid copper(II) carbonate in a test-tube.

(i) Give **three** observations the student would make.

→ bubbles of gas

→ effervescence

→ solution changes blue (4) [2]

(ii) Give the **names** of all products formed.

→ copper sulphate, carbon dioxide, water

(5) [1]

(e) Concentrated sulfuric acid has different properties to dilute sulfuric acid.

When concentrated sulfuric acid is added to glucose, $C_6H_{12}O_6$, steam is given off and a black solid is formed.

(i) Name the black solid. ~~hydrogen sulphate~~ ~~hyd sulphate~~ (6) [1]

(ii) What type of reaction has occurred?

exothermic reaction (7) [1]

1 Correct.

Mark awarded for (a) = 1 out of 1

2 The candidate fails to describe the reaction as being reversible but scores the other 4 marks.

Mark awarded for (b) = 4 out of 5

3 Correct.

Mark awarded for (c) = 1 out of 1

4 The candidate fails to state that the copper(II) carbonate would dissolve.

5 Correct.

Mark awarded for (d) = 2 out of 3

6 The candidate fails to name the substance as carbon.

7 This is a possible alternative answer to 'dehydration'.

Mark awarded for (e) = 1 out of 2

Total mark awarded = 9 out of 12

How the candidate could have improved the answer

(b) The candidate needed to describe the reaction as being reversible.

(d) (i) The candidate needed to state that the copper(II) carbonate would dissolve.

(e) (i) The candidate needed to name the substance as carbon.

Example Candidate Response – Question 5, Middle

5 Sulfuric acid is produced by the Contact process. The steps of the Contact process are shown.

starting material **step 1** → sulfur dioxide **step 2** → sulfur trioxide **step 3** → oleum **step 4** → sulfuric acid

(a) Sulfur is a common starting material for the Contact process.

Name a source of sulfur.

Near volcanoes ..... [1]

(b) Describe **step 2**, giving reaction conditions and a chemical equation. Reference to reaction rate and yield is not required.

Sulfur dioxide mixed with is roasted in excess oxygen to form sulfur trioxide ~~$S + O_2 \rightarrow SO_2$~~. This ~~is an endothermic reaction so it works best at high temperatures~~. It is mixed and then passed over seperate beds of catalyst vanadium (VII) oxide. This forms the sulfur trioxide

$2SO_2 + O_2 \rightarrow 2SO_3$. Heat should be supplied ..... [5]

(c) **Step 3** involves adding sulfur trioxide to concentrated sulfuric acid to form oleum.

Complete the chemical equation for this reaction.

$H_2SO_4 + SO_3 \rightarrow H_2S_2O_7$ [1]

(d) Dilute sulfuric acid is a typical acid.

A student adds excess dilute sulfuric acid to a sample of solid copper(II) carbonate in a test-tube.

(i) Give **three** observations the student would make.

A salt would form, a colourless liquid would form and bubbles would form ..... [2]

(ii) Give the **names** of all products formed.

Copper (II) sulfate, carbon dioxide and water ..... [1]

(e) Concentrated sulfuric acid has different properties to dilute sulfuric acid.

When concentrated sulfuric acid is added to glucose, $C_6H_{12}O_6$, steam is given off and a black solid is formed.

(i) Name the black solid.

Carbon sulfite ..... [1]

(ii) What type of reaction has occurred?

Exothermic reaction ..... [1]

[Total: 12]

Examiner comments

1 Correct.

Mark awarded for (a) = 1 out of 1

2 The candidate fails to describe the reaction as being reversible and does not give the correct temperature (450 °C), pressure (1 to 5 atm) or catalyst (vanadium pentoxide).

Mark awarded for (b) = 1 out of 5

3 Correct.

Mark awarded for (c) = 1 out of 1

4 The candidate fails to state that the copper(II) carbonate would dissolve or that the final colour would be blue.

5 Correct.

Mark awarded for (d) = 1 out of 3

6 The candidate fails to name the substance as carbon.

7 This is a possible alternative answer to 'dehydration'.

Mark awarded for (e) = 1 out of 2

Total mark awarded = 5 out of 12

How the candidate could have improved the answer

(b) The candidate needed to describe the reaction as being reversible and needed to give the correct temperature (450 °C), pressure (1 to 5 atm) and catalyst (vanadium pentoxide).

(d) (i) The candidate needed to state that the copper(II) carbonate would dissolve or that the final colour would be blue.

(e) (i) The candidate needed to name the substance as carbon.

Example Candidate Response – Question 5, Low

5 Sulfuric acid is produced by the Contact process. The steps of the Contact process are shown.

starting material —step 1→ sulfur dioxide —step 2→ sulfur trioxide —step 3→ oleum —step 4→ sulfuric acid

(a) Sulfur is a common starting material for the Contact process.

Name a source of sulfur.

From the oil, which is refined & sulphur is produced. [1] 1

(b) Describe **step 2**, giving reaction conditions and a chemical equation. Reference to reaction rate and yield is not required.

450°C to 700°C and at 10 atmospheric pressure are the reaction conditions. Vanadium Pentoxide is the catalyst use to spur on the reaction.

~~$SO_4 + SH_6 \rightarrow$~~ $SH_4 + SOH \rightarrow S_2 HO_4$

2 [5]

(c) **Step 3** involves adding sulfur trioxide to concentrated sulfuric acid to form oleum.

Complete the chemical equation for this reaction.

$H_2SO_4 + SO_3 \rightarrow$ $H_2S_2O_7$ 3

[1]

H_2SC_7

$H_2S_2O_7$

(d) Dilute sulfuric acid is a typical acid.

A student adds excess dilute sulfuric acid to a sample of solid copper(II) carbonate in a test-tube.

(i) Give **three** observations the student would make.

- The solid copper (II) carbonate would change color.
- It would react and dissolve completely.
- It would leave behind a reddish-brown color. [2] 4

(ii) Give the **names** of all products formed.

- Copper Sulphate
- Carbon sulfate. 5 [1]

(e) Concentrated sulfuric acid has different properties to dilute sulfuric acid.

When concentrated sulfuric acid is added to glucose, $C_6H_{12}O_6$, steam is given off and a black solid is formed.

(i) Name the black solid.

Carbon. 6 [1]

(ii) What type of reaction has occurred?

A displacement reaction. 7 [1]

[Total: 12]

Examiner comments

1 The candidate fails to state that it is crude oil which is a source of sulfur.

Mark awarded for (a) = 0 out of 1

2 The candidate fails to describe the reaction as being reversible and fails to give the correct temperature (450 °C), pressure (1 to 5 atm) or a balanced equation.

Mark awarded for (b) = 1 out of 5

3 Correct.

Mark awarded for (c) = 1 out of 1

4 The candidate fails to state that the copper(II) carbonate would effervesce or that the final colour would be blue

5 The candidate fails to state that water and carbon dioxide would form as well as copper(II) sulfate.

Mark awarded for (d) = 0 out of 3

6 Correct.

7 This is not allowed as an alternative answer to 'dehydration'.

Mark awarded for (e) = 1 out of 2

Total mark awarded = 3 out of 12

How the candidate could have improved the answer

(b) The candidate needed to describe the reaction as being reversible and needed to give the correct temperature (450 °C), pressure (1 to 5 atm) and write an equation,

(d) (i) The candidate needed to state that the copper(II) carbonate would effervesce or that the final colour would be blue.

(d) (ii) The candidate needed to state that water and carbon dioxide would form as well as copper(II) sulfate.

Common mistakes candidates made in this question

(b) Not stating the temperature, pressure and catalyst needed for the Contact process.

(d) (i) Not stating the three observations which can be made when copper(II) carbonate reacts with an acid.

(e) (i) Not stating that concentrated sulfuric acid dehydrates sugar.

Question 6

Example Candidate Response – Question 6, High	Examiner comments

6 Petroleum is a source of many important chemicals.

(a) Name **two** industrial processes which must take place to produce alkenes from petroleum.

Fractional Distillation, Cracking

1

[2]

(b) Ethene, $CH_2=CH_2$, and propene, $CH_2=CHCH_3$, can both be converted into polymers.

(i) What type of polymerisation takes place when ethene forms a polymer?

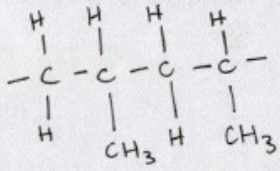
Addition Polymerisation [1]

(ii) What is the empirical formula of the polymer formed from ethene?

[1]

(iii) Propene has the structural formula $CH_2=CHCH_3$.

Draw **two** repeat units of the polymer made from propene.



2

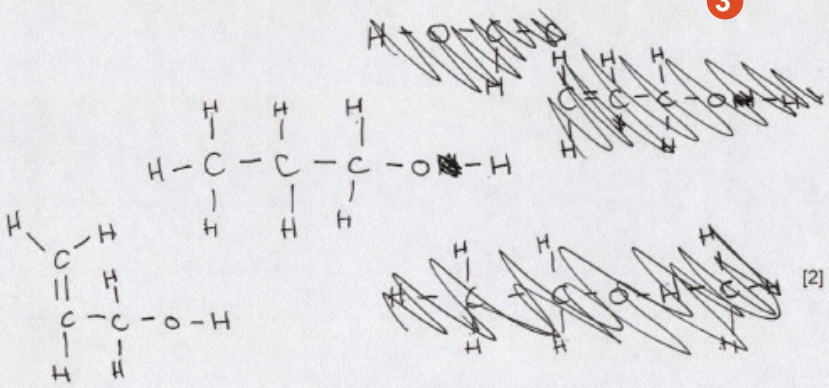
[2]

(c) Ethene will react with steam to form ethanol.

Propene will react with steam to form two isomers, both of which are alcohols.

Suggest the structures of these alcohols.

3



[2]

1 Correct.

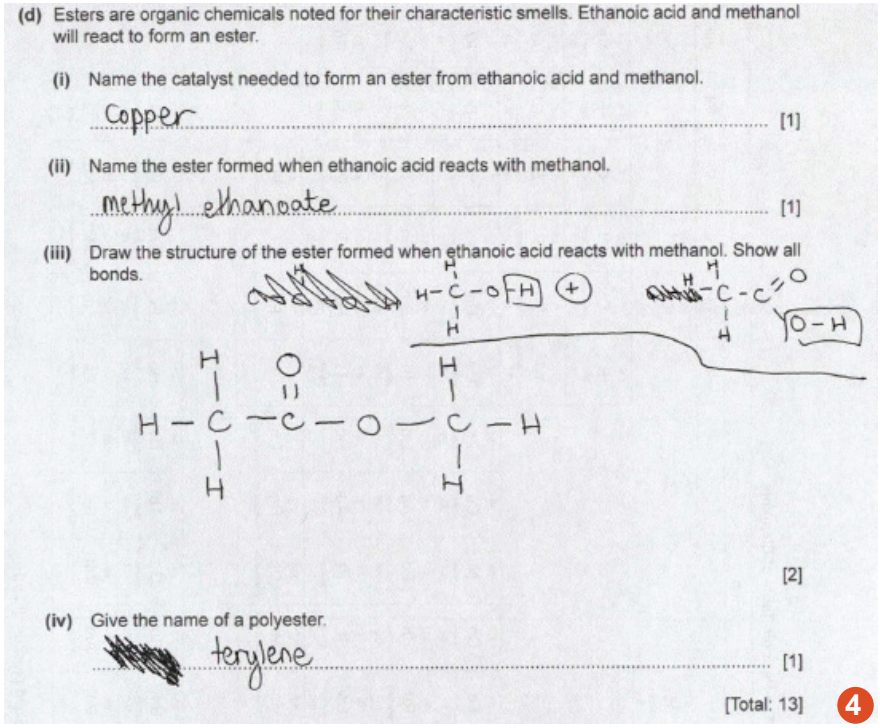
Mark awarded for (a) = 2 out of 2

2 The answers are correct except that the candidate fails to show the empirical formula of the polymer.

Mark awarded for (b) = 3 out of 4

3 The candidate fails to draw the structure of propan-2-ol.

Mark awarded for (c) = 1 out of 2

Example Candidate Response – Question 6, High	Examiner comments
	4 This is correct except that the candidate fails to name the catalyst used in the formation of esters from carboxylic acids and alcohols. Mark awarded for (d) = 4 out of 5 **Total mark awarded = 10 out of 12**

How the candidate could have improved the answer

(b) The answer was correct except that the candidate needed to show the empirical formula of the polymer.

(c) The candidate needed to draw the structure of propan-2-ol.

(d) The answer was correct but the candidate also needed to name the catalyst used in the formation of esters from carboxylic acids and alcohols.

Example Candidate Response – Question 6, Low	Examiner comments

6 Petroleum is a source of many important chemicals.

(a) Name **two** industrial processes which must take place to produce alkenes from petroleum.

→ Burning of ~~fossil~~ fossil fuel.

→ Extracting petroleum 1 [2]

(b) Ethene, $CH_2=CH_2$, and propene, $CH_2=CHCH_3$, can both be converted into polymers.

(i) What type of polymerisation takes place when ethene forms a polymer?

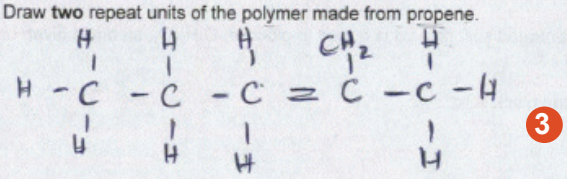
Addition polymerisation. [1]

(ii) What is the empirical formula of the polymer formed from ethene?

~~C_2H_4~~ C_6H_8 2 [1]

(iii) Propene has the structural formula $CH_2=CHCH_3$.

Draw **two** repeat units of the polymer made from propene.



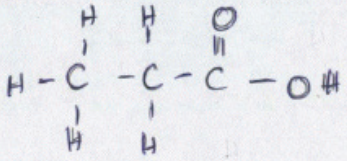
3

[2]

(c) Ethene will react with steam to form ethanol.

Propene will react with steam to form two isomers, both of which are alcohols.

Suggest the structures of these alcohols.



4

1 The candidate fails to correctly name two industrial processes.

Mark awarded for (a) = 0 out of 2

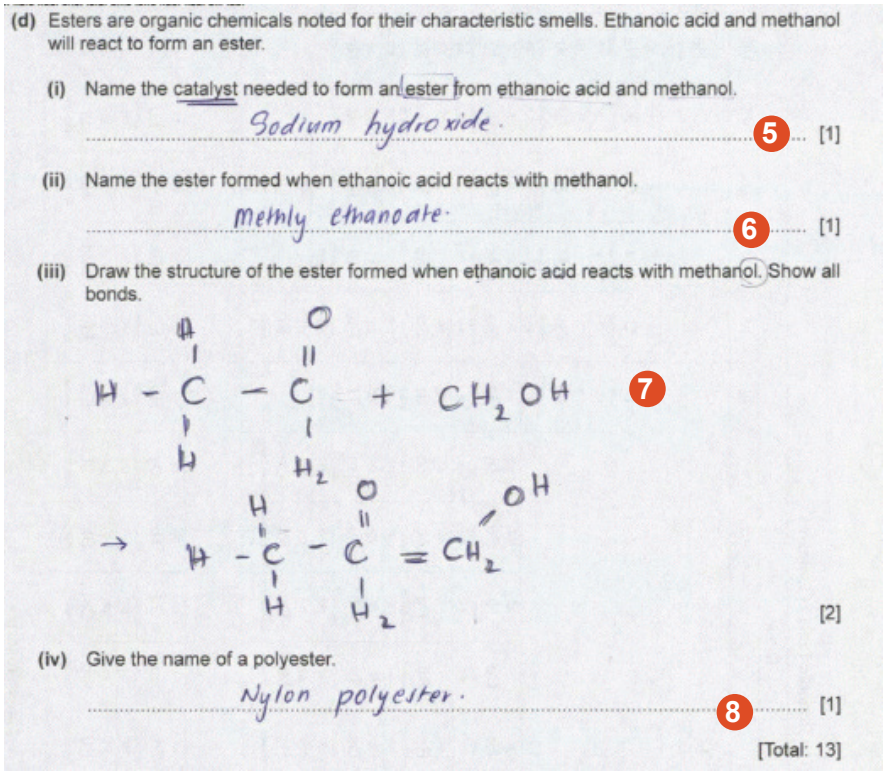
2 The candidate fails to show the empirical formula of the polymer.

3 The candidate fails to draw two repeat units of the polymer

Mark awarded for (b) = 1 out of 4

4 The candidate fails to draw the structures of the two alcohols.

Mark awarded for (c) = 0 out of 2

Example Candidate Response – Question 6, Low	Examiner comments
	5 The candidate fails to name the catalyst used in the formation of esters from carboxylic acids and alcohols. 6 The candidate fails to draw the structures of the two alcohols. 7 The candidate fails to draw an ester. 8 The candidate fails to name a polyester. Mark awarded for (d) = 1 out of 5 **Total mark awarded = 2 out of 12**

How the candidate could have improved the answer

(a) The candidate needed to give the two industrial processes.

(b) (i) The candidate needed to show the empirical formula of the polymer.

(b) (iii) The candidate needed to draw two repeat units of the polymer.

(c) The candidate needed to draw the structures of the two alcohols.

(d) (i) The candidate needed to name the catalyst used in the formation of esters from carboxylic acids and alcohols.

(d) (iii) The candidate needed to draw the correct ester.

(d) (iv) The candidate needed to correctly name a polyester.

Common mistakes candidates made in this question

(b) (ii) Not realising that an addition polymer must have the same empirical formula as the monomer from which it is made.

(b) (iii) Assuming that two repeat units of (poly)propene is 6 CH_2 groups in a row.

(d) (iv) Thinking that nylon is a polyester.

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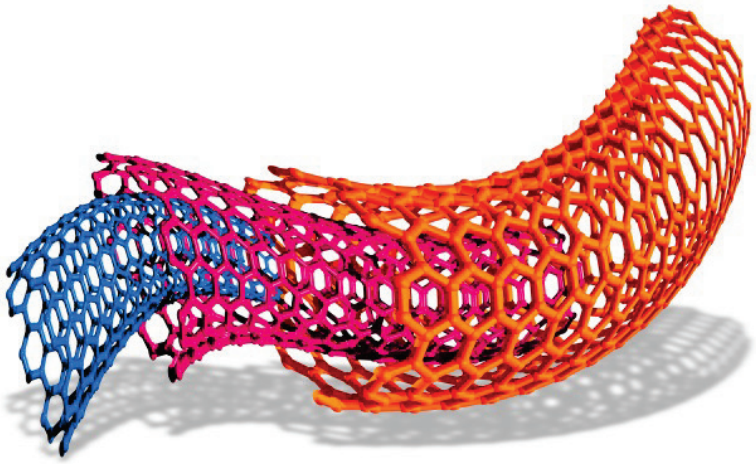
Example Candidate Responses
Paper 5

Cambridge IGCSE™
Chemistry 0620



Version 2.0

Cambridge Pathway

In order to help us develop the highest quality resources, we are undertaking a continuous programme of review; not only to measure the success of our resources but also to highlight areas for improvement and to identify new development needs.

We invite you to complete our survey by visiting the website below. Your comments on the quality and relevance of our resources are very important to us.

www.surveymonkey.co.uk/r/GL6ZNJB

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Please follow the link below to register your interest.

www.cambridgeinternational.org/cambridge-for/teachers/teacherconsultants/

Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching IGCSE Chemistry (0620), and to show how different levels of candidates' performance (high, middle and low) relate to the subject's curriculum and assessment objectives.

In this booklet candidate responses have been chosen to exemplify a range of answers. Each response is accompanied by a brief commentary explaining the strengths and weaknesses of the answers.

For each question, response is annotated with clear explanation of where and why marks were awarded or omitted. This, in turn, is followed by examiner comments on how the answer could have been improved. In this way it is possible for you to understand what candidates have done to gain their marks and what they will have to do to improve their marks. At the end there is a list of common mistakes candidates made in their answers for each question.

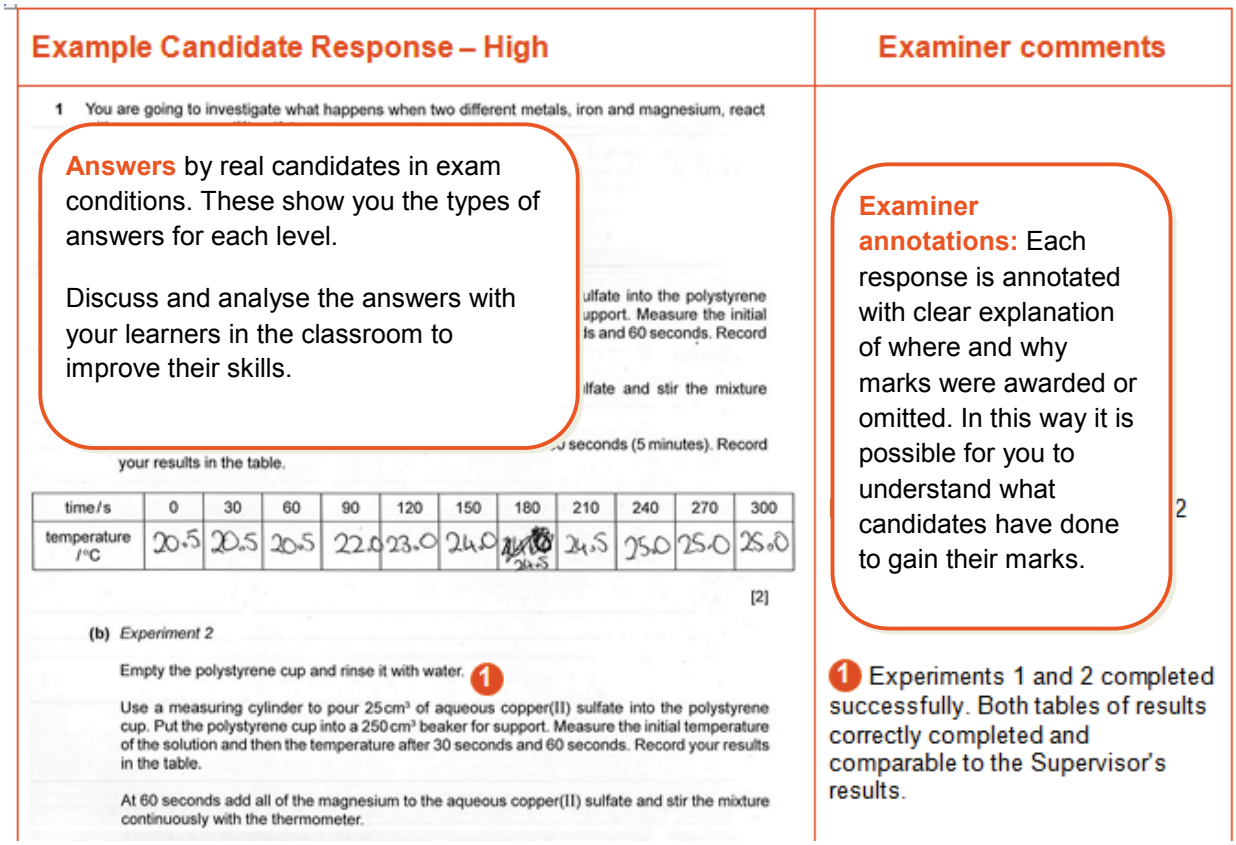
This document provides illustrative examples of candidate work. These help teachers to assess the standard required to achieve marks, beyond the guidance of the mark scheme. Some question types where the answer is clear from the mark scheme, such as short answers and multiple choice, have therefore been omitted.

The questions, mark schemes and pre-release material used here are available to download as a zip file from the School Support Hub as the Example Candidate Responses Files. These files are:

Question Paper 31, June 2016	
Question paper	0620_s16_qp_31.pdf
Mark scheme	0620_s16_ms_31.pdf
Question Paper 41, June 2016	
Question paper	0620_s16_qp_41.pdf
Mark scheme	0620_s16_ms_41.pdf
Question Paper 51, November 2016	
Question paper	0620_w16_qp_52.pdf
Mark scheme	0620_w16_ms_52.pdf
Question Paper 61, June 2016	
Question paper	0620_s16_qp_61.pdf
Mark scheme	0620_s16_ms_61.pdf

Other past papers, Examiner Reports and other teacher support materials are available on the School Support Hub at www.cambridgeinternational.org/support

How to use this booklet



Example Candidate Response – High

Examiner comments

1 You are going to investigate what happens when two different metals, iron and magnesium, react

ulfate into the polystyrene
upport. Measure the initial
ls and 60 seconds. Record

lfate and stir the mixture

seconds (5 minutes). Record
your results in the table.

time / s	0	30	60	90	120	150	180	210	240	270	300
temperature / °C	20.5	20.5	20.5	22.0	23.0	24.0	24.5	24.5	25.0	25.0	25.0

[2]

(b) *Experiment 2*

Empty the polystyrene cup and rinse it with water. 1

Use a measuring cylinder to pour 25 cm³ of aqueous copper(II) sulfate into the polystyrene cup. Put the polystyrene cup into a 250 cm³ beaker for support. Measure the initial temperature of the solution and then the temperature after 30 seconds and 60 seconds. Record your results in the table.

At 60 seconds add all of the magnesium to the aqueous copper(II) sulfate and stir the mixture continuously with the thermometer.

2

1 Experiments 1 and 2 completed successfully. Both tables of results correctly completed and comparable to the Supervisor's results.

Answers by real candidates in exam conditions. These show you the types of answers for each level.

Discuss and analyse the answers with your learners in the classroom to improve their skills.

Examiner annotations: Each response is annotated with clear explanation of where and why marks were awarded or omitted. In this way it is possible for you to understand what candidates have done to gain their marks.

How the candidate could have improved the answer

The candidate lost marks by not reading the question careful
This careful reading is needed, particularly when answering t

Examiner comments on how the answer could have been improve.

Common mistakes candidates made in this question

- Lack of smooth line graphs and incorrect
- Explanations not given where requested.
- Failure to give the number of points indic

Common mistakes a list of common mistakes candidates made in their answers for each question.

Assessment at a glance

All candidates must enter for three papers.

Core candidates take:	Extended candidates take:
Paper 1 45 minutes A multiple-choice paper consisting of 40 items of the four-choice type. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Core syllabus content. This paper will be weighted at 30% of the final total mark.	**Paper 2** 45 minutes A multiple-choice paper consisting of 40 items of the four-choice type. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Extended syllabus content (Core and Supplement). This paper will be weighted at 30% of the final total mark.
and:	**and:**
Paper 3 1 hour 15 minutes A written paper consisting of short-answer and structured questions. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Core syllabus content. 80 marks This paper will be weighted at 50% of the final total mark.	**Paper 4** 1 hour 15 minutes A written paper consisting of short-answer and structured questions. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Extended syllabus content (Core and Supplement). 80 marks This paper will be weighted at 50% of the final total mark.

All candidates take	
either:	**or:**
Paper 5 1 hour 15 minutes Practical Test This paper will test assessment objective AO3. Questions will be based on the experimental skills in Section 7. The paper is structured to assess grade ranges A*–G. 40 marks This paper will be weighted at 20% of the final total mark.	**Paper 6** 1 hou Alternative to Practical This paper will test assessment objective AO3. Questions will be based on the experimental skills in Section 7. The paper is structured to assess grade ranges A*–G. 40 marks This paper will be weighted at 20% of the final total mark.

Candidates who have studied the Core syllabus content, or who are expected to achieve a grade D or below should be entered for Paper 1, Paper 3 and either Paper 5 or Paper 6. These candidates will be eligible for grades C to G.

Candidates who have studied the Extended syllabus content (Core and Supplement), and who are expected to achieve a grade C or above should be entered for Paper 2, Paper 4 and either Paper 5 or Paper 6. These candidates will be eligible for grades A* to G.

Teachers are reminded that the latest syllabus is available on our public website at www.cambridgeinternational.org and the School Support Hub at www.cambridgeinternational.org/support

Paper 5 – Practical Test

Question 1

Example Candidate Response – Question 1, High	Examiner comments

1 You are going to investigate what happens when two different metals, iron and magnesium, react with aqueous copper(II) sulfate.

Read all the instructions carefully before starting the experiments.

Instructions
You are going to carry out two experiments.

(a) *Experiment 1*

Use a measuring cylinder to pour 25 cm^3 of aqueous copper(II) sulfate into the polystyrene cup provided. Put the polystyrene cup into a 250 cm^3 beaker for support. Measure the initial temperature of the solution and then the temperature after 30 seconds and 60 seconds. Record your results in the table.

At 60 seconds add all of the iron to the aqueous copper(II) sulfate and stir the mixture continuously with the thermometer.

Measure the temperature of the mixture every 30 seconds for 300 seconds (5 minutes). Record your results in the table.

time / s	0	30	60	90	120	150	180	210	240	270	300
temperature / °C	20.5	20.5	20.5	22.0	23.0	24.0	24.5	24.5	25.0	25.0	25.0

[2]

(b) *Experiment 2*

Empty the polystyrene cup and rinse it with water.

Use a measuring cylinder to pour 25 cm^3 of aqueous copper(II) sulfate into the polystyrene cup. Put the polystyrene cup into a 250 cm^3 beaker for support. Measure the initial temperature of the solution and then the temperature after 30 seconds and 60 seconds. Record your results in the table.

At 60 seconds add all of the magnesium to the aqueous copper(II) sulfate and stir the mixture continuously with the thermometer.

Measure the temperature of the mixture every 30 seconds for 300 seconds (5 minutes). Record your results in the table.

time / s	0	30	60	90	120	150	180	210	240	270	300
temperature / °C	20.5	20.5	20.5	83.0	86.5	86.0	85.0	83.5	81.0	78.5	76.5

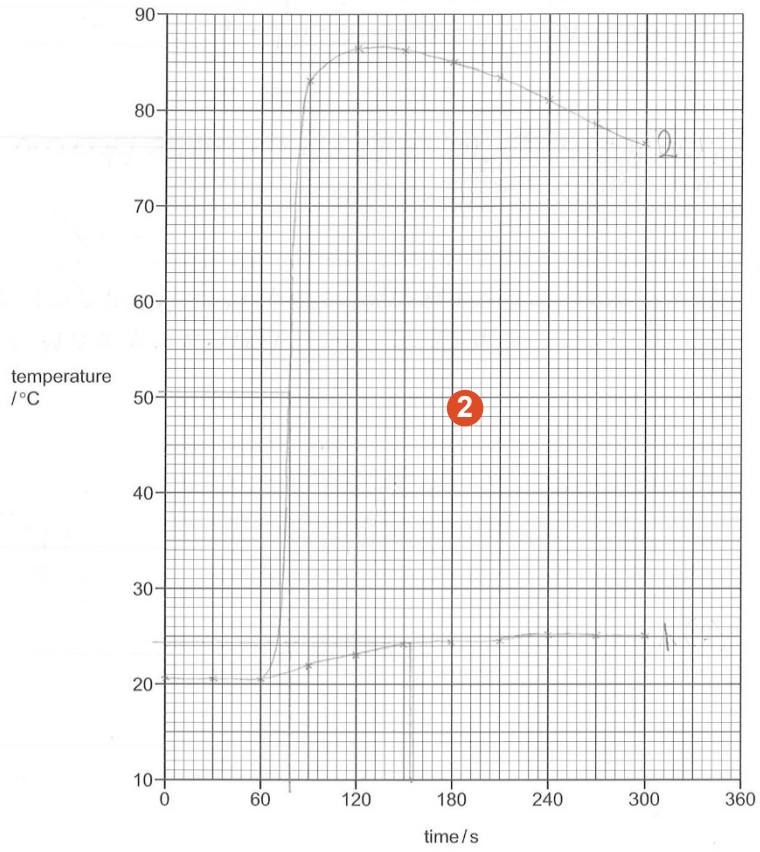
1

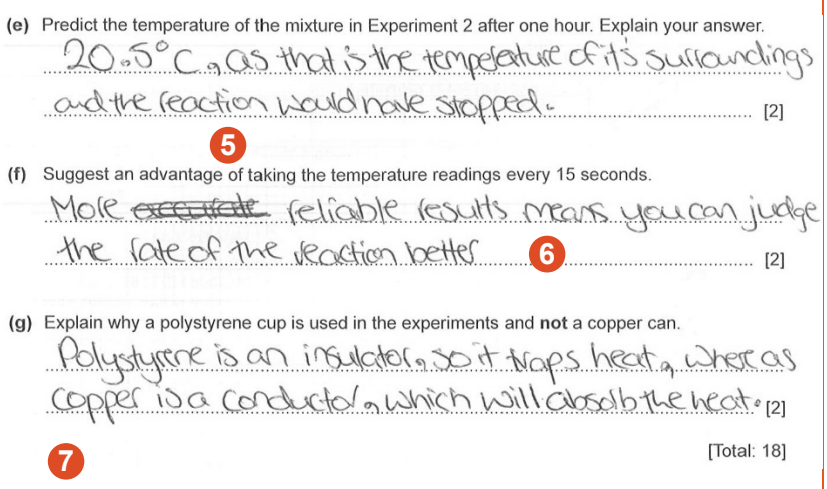
[2]

1 Experiments 1 and 2 have been completed successfully. Both tables of results are completed correctly and they are comparable to the supervisor's results.

Mark awarded for (a) = 2 out of 2

Mark awarded for (b) = 2 out of 2

Example Candidate Response – Question 1, High	Examiner comments
(c) Plot the results for Experiments 1 and 2 on the grid and draw **two** smooth line graphs. Clearly label the graphs.  [4]	**2** All the points are correctly plotted and the line graphs are drawn smoothly. The graphs are clearly labelled as requested. Mark awarded for (c) = 4 out of 4
(d) (i) **From your graph**, deduce the temperature of the mixture in Experiment 1 after 135 seconds. Show clearly **on the grid** how you worked out your answer. **3** 24.5 °C [2]	**3** The tie line is wrongly drawn from 153 seconds. Credit is given for reading the value from this tie line. Mark awarded for (d) (i) = 1 out of 2
(ii) **From your graph**, deduce the time taken for the temperature of the mixture in Experiment 2 to change by 30 °C **after the magnesium was added**. Show clearly **on the grid** how you worked out your answer. 78 s [2] **4**	**4** The tie line shows the candidate understands that the temperature will have risen to 20.5 + 30 = 50.5 °C. The time of 78 s is correct but 60 seconds need to be subtracted from this value because the time required is after the magnesium has been added. Mark awarded for (d) (ii) = 1 out of 2

Example Candidate Response – Question 1, High	Examiner comments
 (e) Predict the temperature of the mixture in Experiment 2 after one hour. Explain your answer. 20.5°C, as that is the temperature of it's surroundings and the reaction would have stopped. [2] 5 (f) Suggest an advantage of taking the temperature readings every 15 seconds. More ~~accurate~~ reliable results means you can judge the rate of the reaction better 6 [2] (g) Explain why a polystyrene cup is used in the experiments and **not** a copper can. Polystyrene is an insulator, so it traps heat, whereas copper is a conductor, which will absorb the heat. [2] 7 [Total: 18]	5 The candidate realises the reaction is finished. After 1 hour the mixture would have returned to the initial temperature recorded in the table as 20.5 °C. Mark awarded for (e) = 2 out of 2 6 Credit is given for 'more results' but the point about reliability is ignored because it is not relevant. Understanding that the resultant graph would be a smoother/better curve would have gained full credit. Mark awarded for (f) = 1 out of 2 7 The candidate shows knowledge and understanding of the properties of polystyrene. Mark awarded for (g) = 2 out of 2 **Total mark awarded = 15 out of 18**

How the candidate could have improved the answer

The candidate lost marks by not reading the questions carefully, e.g. drawing the wrong tie line. Careful reading was required, especially when answering the more difficult questions.

Example Candidate Response – Question 1, Middle

1 You are going to investigate what happens when two different metals, iron and magnesium, react with aqueous copper(II) sulfate.

Read all the instructions carefully before starting the experiments.

Instructions
You are going to carry out two experiments.

(a) *Experiment 1*

Use a measuring cylinder to pour 25 cm^3 of aqueous copper(II) sulfate into the polystyrene cup provided. Put the polystyrene cup into a 250 cm^3 beaker for support. Measure the initial temperature of the solution and then the temperature after 30 seconds and 60 seconds. Record your results in the table.

At 60 seconds add all of the iron to the aqueous copper(II) sulfate and stir the mixture continuously with the thermometer.

Measure the temperature of the mixture every 30 seconds for 300 seconds (5 minutes). Record your results in the table.

time / s	0	30	60	90	120	150	180	210	240	270	300
temperature / °C	18	17	17	18	20	21	22	22	23	23	24

[2]

(b) *Experiment 2*

Empty the polystyrene cup and rinse it with water.

Use a measuring cylinder to pour 25 cm^3 of aqueous copper(II) sulfate into the polystyrene cup. Put the polystyrene cup into a 250 cm^3 beaker for support. Measure the initial temperature of the solution and then the temperature after 30 seconds and 60 seconds. Record your results in the table.

At 60 seconds add all of the magnesium to the aqueous copper(II) sulfate and stir the mixture continuously with the thermometer.

Measure the temperature of the mixture every 30 seconds for 300 seconds (5 minutes). Record your results in the table.

time / s	0	30	60	90	120	150	180	210	240	270	300
temperature / °C	18	18	18	60	78	80	80	78	77	74	73

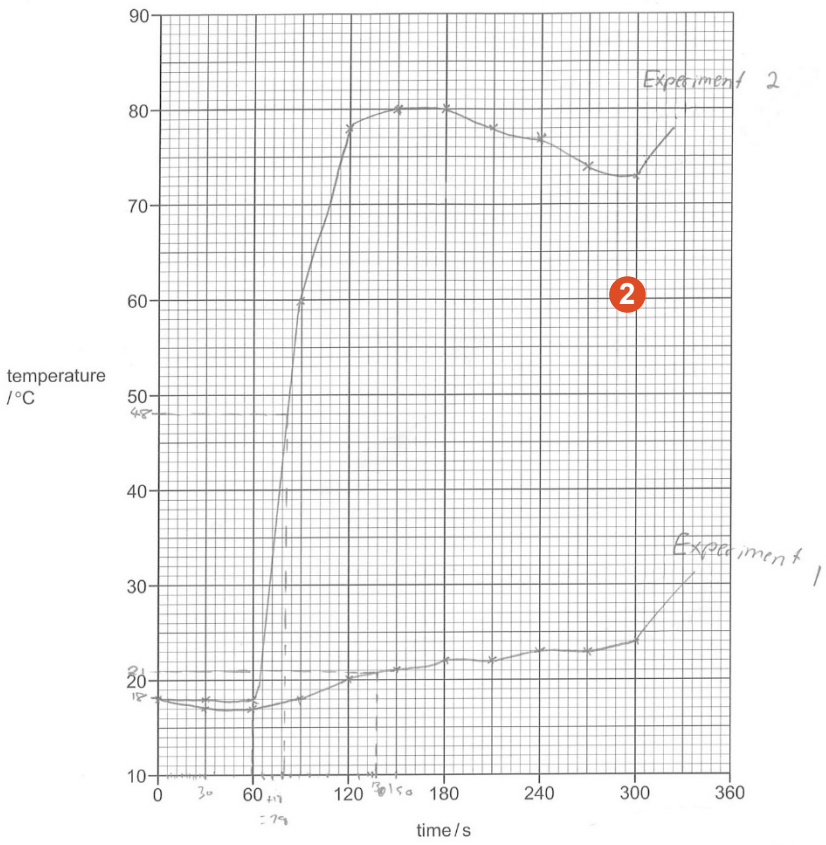
1 [2]

Examiner comments

1 Both experiments have been carried out. The tables of results are completed correctly. The first three readings should be similar to show the instructions have been followed as requested.

Mark awarded for (a) = 2 out of 2

Mark awarded for (b) = 2 out of 2

Example Candidate Response – Question 1, Middle	Examiner comments
(c) Plot the results for Experiments 1 and 2 on the grid and draw **two** smooth line graphs. Clearly label the graphs.  [4] **(d) (i)** **From your graph**, deduce the temperature of the mixture in Experiment 1 after 135 seconds. Show clearly **on the grid** how you worked out your answer. 3 21 °C ..... °C [2] **(ii)** **From your graph**, deduce the time taken for the temperature of the mixture in Experiment 2 to change by 30 °C **after the magnesium was added**. Show clearly **on the grid** how you worked out your answer. 4 18 ..... s [2]	2 All points are plotted correctly. The line graphs are not smooth and go up at the end so only partial credit is given for the labels. Mark awarded for (c) = 3 out of 4 3 The tie line is incorrectly positioned at 138*s* but credit is given for the value. Mark awarded for (d) (i) = 1 out of 2 4 The candidate shows a good understanding of the steps required to work out the answer. The tie line at 48 °*C* is clearly shown. Mark awarded for (d) (ii) = 2 out of 2

Example Candidate Response – Question 1, Middle	Examiner comments
(e) Predict the temperature of the mixture in Experiment 2 after one hour. Explain your answer. 19 °C, it would've naturally cooled down back to room temperature. 5 [2] (f) Suggest an advantage of taking the temperature readings every 15 seconds. You will get more accurate results on the graph. 6 [2] (g) Explain why a polystyrene cup is used in the experiments and **not** a copper can. Copper is conductive and also may react with the experiment, polystyrene is not conductive and will not react. 7 [2] [Total: 18]	5 The candidate does not give an explanation for a correct answer in terms of the reaction finishing. Mark awarded for (e) = 1 out of 2 6 Reference to accuracy alone is not enough. The idea of more readings leading to a smoother graph is required. Mark awarded for (f) = 0 out of 2 7 The idea that copper conducts heat gains credit. There is no explanation in terms of heat losses causing errors in the results. Mark awarded for (g) = 1 out of 2 **Total mark awarded = 12 out of 18**

How the candidate could have improved the answer

The two graphs drawn were not smooth. Graphs should be straight lines drawn with a ruler or smooth curves.

No explanations were given in response to questions with the command word 'Explain'.

Example Candidate Response – Question 1, Low	Examiner comments

1 You are going to investigate what happens when two different metals, iron and magnesium (powder), react with aqueous copper(II) sulfate.

Read all the instructions carefully before starting the experiments.

Instructions
You are going to carry out two experiments.

(a) *Experiment 1*

Use a measuring cylinder to pour 25 cm^3 of aqueous copper(II) sulfate into the polystyrene cup provided. Put the polystyrene cup into a 250 cm^3 beaker for support. Measure the initial temperature of the solution and then the temperature after 30 seconds and 60 seconds. Record your results in the table.

At 60 seconds add all of the iron to the aqueous copper(II) sulfate and stir the mixture continuously with the thermometer.

Measure the temperature of the mixture every 30 seconds for 300 seconds (5 minutes). Record your results in the table.

time / s	0	30	60	90	120	150	180	210	240	270	300
temperature / °C	19	19	19	21	22	22	22.5	23	23	23.5	23.5

[2]

(b) *Experiment 2*

Empty the polystyrene cup and rinse it with water. 1

Use a measuring cylinder to pour 25 cm^3 of aqueous copper(II) sulfate into the polystyrene cup. Put the polystyrene cup into a 250 cm^3 beaker for support. Measure the initial temperature of the solution and then the temperature after 30 seconds and 60 seconds. Record your results in the table.

At 60 seconds add all of the magnesium to the aqueous copper(II) sulfate and stir the mixture continuously with the thermometer.

Measure the temperature of the mixture every 30 seconds for 300 seconds (5 minutes). Record your results in the table.

time / s	0	30	60	90	120	150	180	210	240	270	300
temperature / °C	19	19	19	78	85	87	85	84	81.5	79	77

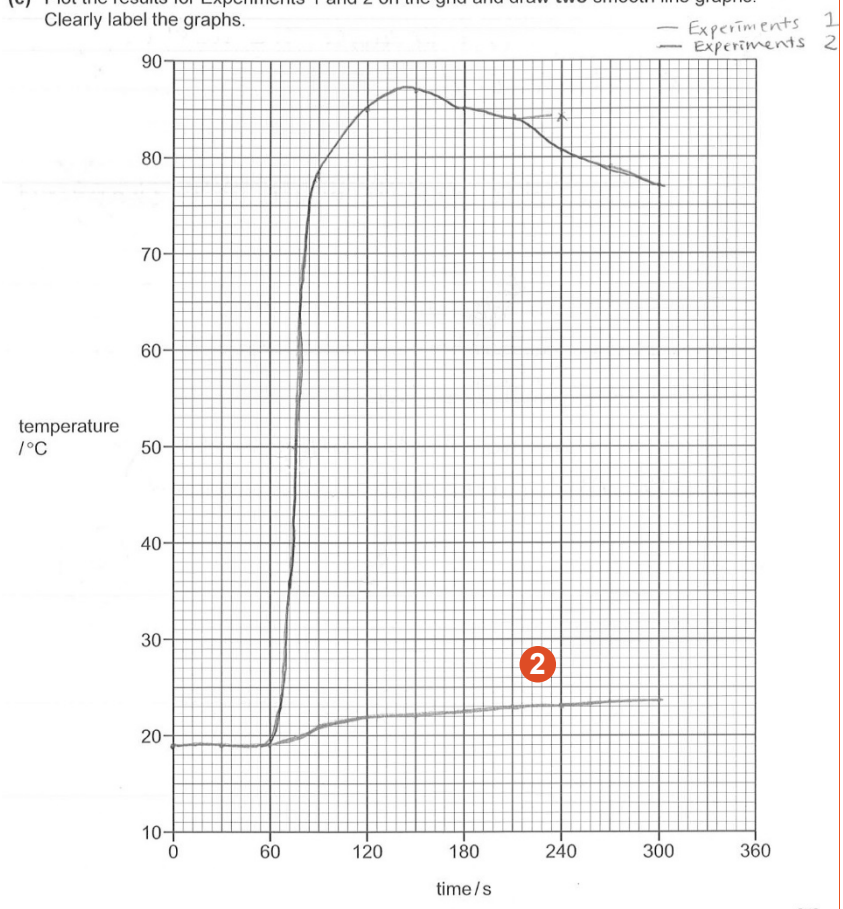
[2]

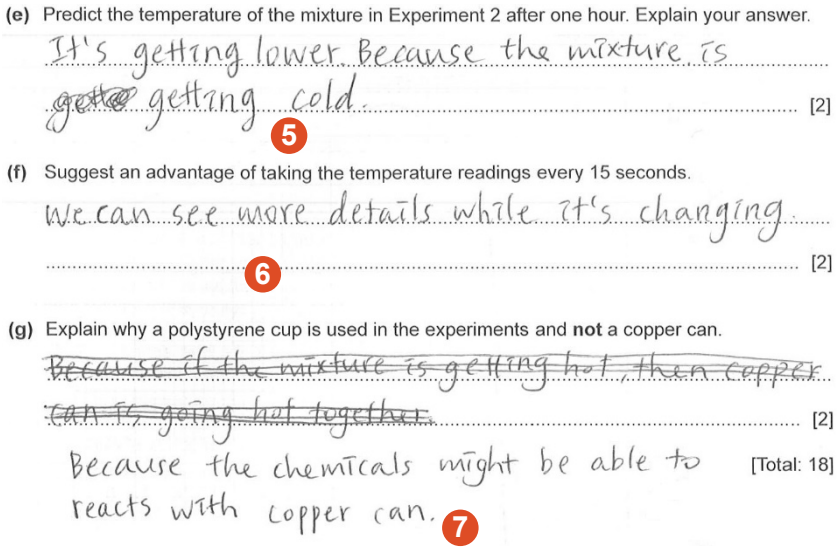
1 Experiments 1 and 2 have been carried out successfully.

Both tables of results are completed correctly.

Mark awarded for (a) = 2 out of 2

Mark awarded for (b) = 2 out of 2

Example Candidate Response – Question 1, Low	Examiner comments
(c) Plot the results for Experiments 1 and 2 on the grid and draw **two** smooth line graphs. Clearly label the graphs.  [4] (d) (i) **From your graph**, deduce the temperature of the mixture in Experiment 1 after 135 seconds. Show clearly **on the grid** how you worked out your answer. 3 ..... 22 ..... °C [2] (ii) **From your graph**, deduce the time taken for the temperature of the mixture in Experiment 2 to change by 30 °C **after the magnesium was added**. Show clearly **on the grid** how you worked out your answer. 4 ..... 60 ..... s [2]	2 All points are plotted correctly and the graph is smooth. Mark awarded for (c) = 4 out of 4 3 The candidate has read the value correctly but fails to show clearly on the grid how the answer is worked out. Mark awarded for (d) (i) = 1 out of 2 4 There is a lack of knowledge and understanding. Mark awarded for (d) (ii) = 0 out of 2

Example Candidate Response – Question 1, Low	Examiner comments
	5 The candidate gives a vague answer which is not enough to gain credit. The explanation that the reaction is finished and the temperature of the mixture would return to room temperature is not realised. Mark awarded for (e) = 0 out of 2 6 No appreciation is evident here that more results would be obtained which would result in a smoother graph. Mark awarded for (f) = 0 out of 2 7 There is a lack of knowledge and understanding about the insulating properties of polystyrene results in a guessed answer. Mark awarded for (g) = 0 out of 2 **Total mark awarded = 9 out of 18**

How the candidate could have improved the answer

The instruction to 'Show clearly **on the grid**…' was ignored.

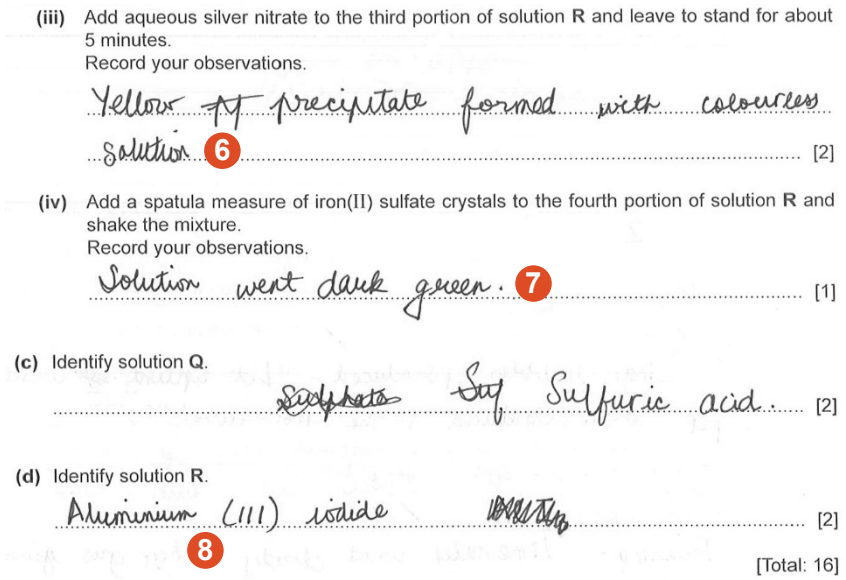
More detail was needed in answers which showed a vague approach and a lack of knowledge and understanding.

Common mistakes candidates made in this question

- Line graphs were not smooth.
- Tie lines were incorrect.
- Not giving explanations when requested.
- Not giving the number of points indicated by the mark allocation of the question.

Question 2

Example Candidate Response – Question 2, High	Examiner comments
2 You are provided with two solutions, solution **Q** and solution **R**. Carry out the following tests on solution **Q** and solution **R**, recording all of your observations at each stage. **tests on solution Q** **(a)** Divide solution **Q** into four equal portions in four test-tubes. Carry out the following tests. **(i)** Use pH indicator paper to measure the pH of the first portion of solution **Q**. pH 2 (1) [1] **(ii)** Add a 2 cm strip of magnesium ribbon to the second portion of solution **Q**. Test the gas given off. Record your observations. Fizzing, bubbles produced. Lit splint went 'pop' when introduced to the test-tube. (2) [2] **(iii)** Add a spatula measure of sodium carbonate to the third portion of solution **Q**. Test the gas given off. Record your observations. Fizzing. Limewater went cloudy when gas given off was ran through it, used a pippette. [2] **(iv)** Add a few drops of dilute nitric acid and about 1 cm^3 of aqueous barium nitrate to the fourth portion of solution **Q**. Record your observations. White precipitate formed. (3) [1] **tests on solution R** **(b)** Divide solution **R** into four equal portions in four test-tubes. Carry out the following tests. **(i)** Measure the pH of the first portion of solution **R**. pH 10 (4) [1] **(ii)** Add several drops of aqueous sodium hydroxide to the second portion of solution **R** and shake the test-tube. Then add excess aqueous sodium hydroxide to the test-tube. Record your observations. ~~When added excess drops of NaOH the solution went colourless with white precipitate~~ [2] when added few drops white precipitate when added excess NaOH clear colourless solution with no precipitate. (5)	(1) *pH* value is in the correct range (0–3). Mark awarded for (a) (i) = 1 out of 1 (2) Fizzing is observed. The correct tests on gases are produced and the results of the tests are clearly stated. Mark awarded for (a) (ii) = 2 out of 2 Mark awarded for (a) (iii) = 2 out of 2 (3) The expected observation is given. Mark awarded for (a) (iv) = 1 out of 1 (4) *pH* value is in the allowed range (10–14). Mark awarded for (b) (i) = 1 out of 1 (5) The wrong result is given for when excess aqueous sodium hydroxide is added. The answer should be insoluble. Mark awarded for (b) (ii) = 1 out of 2

Example Candidate Response – Question 2, High	Examiner comments
	6 The precipitate is incorrectly described as yellow instead of brown. Mark awarded for (b) (iii) = 1 out of 2 7 The candidate fails to note the presence of a precipitate. Mark awarded for (b) (iv) = 0 out of 1 Mark awarded for (c) = 2 out of 2 8 The candidate fails to work out that the *pH* value of 10 obtained in (b) (i) indicates the presence of hydroxide ions. The presence of iodide ions has been inferred from an erroneous observation in (b) (iii). Mark awarded for (d) = 0 out of 2 **Total mark awarded = 11 out of 16**

How the candidate could have improved the answer

Some observations were not fully described, e.g. dark green precipitate was only given as dark green.

Example Candidate Response – Question 2, Middle

2 You are provided with two solutions, solution **Q** and solution **R**.
Carry out the following tests on solution **Q** and solution **R**, recording all of your observations at each stage.

tests on solution Q

(a) Divide solution **Q** into four equal portions in four test-tubes. Carry out the following tests.

(i) Use pH indicator paper to measure the pH of the first portion of solution **Q**.

pH ..1.. [1]

(ii) Add a 2 cm strip of magnesium ribbon to the second portion of solution **Q**. Test the gas given off.
Record your observations.

when magnesium was added it bubbled and when a lit splint was added it poped gas is hydrogen [2]

(iii) Add a spatula measure of sodium carbonate to the third portion of solution **Q**. Test the gas given off.
Record your observations.

bubble put gas through limewater turned cloudy, gas is co2 [2]

(iv) Add a few drops of dilute nitric acid and about 1 cm^3 of aqueous barium nitrate to the fourth portion of solution **Q**.
Record your observations.

cloudy percipate formed from colourless solution [1]

tests on solution R

(b) Divide solution **R** into four equal portions in four test-tubes. Carry out the following tests.

(i) Measure the pH of the first portion of solution **R**.

pH ..3.. [1]

(ii) Add several drops of aqueous sodium hydroxide to the second portion of solution **R** and shake the test-tube.
Then add excess aqueous sodium hydroxide to the test-tube.
Record your observations.

When added in small amounts unreacted when in excess still unreactive [2]

Examiner comments

1 pH is in the correct range (0–3).

Mark awarded for (a) (i) = 1 out of 1

2 Bubbles are seen and recorded. The lighted splint test is stated and the result obtained gains full credit.

Mark awarded for (a) (ii) = 2 out of 2

3 Bubbles are recorded and 'limewater turns cloudy' is the expected test for carbon dioxide gas.

Mark awarded for (a) (iii) = 2 out of 2

4 Cloudy, milky and turbid are not specific descriptions for a positive sulfate test. White precipitate is specific.

Mark awarded for (a) (iv) = 0 out of 1

Mark awarded for (b) (i) = 0 out of 1

5 The candidate shows a lack of knowledge and understanding of the use of aqueous sodium hydroxide to identify metal cations.

Mark awarded for (b) (ii) = 0 out of 2

Example Candidate Response – Question 2, Middle	Examiner comments
(iii) Add aqueous silver nitrate to the third portion of solution **R** and leave to stand for about 5 minutes. Record your observations. turned from etc colourless Solution to dark brown then to light brown then finally stayed the same [2] (iv) Add a spatula measure of iron(II) sulfate crystals to the fourth portion of solution **R** and shake the mixture. Record your observations. 6 turned clear ~~substance~~ colourless solution to dark cream [1] (c) Identify solution **Q**. Hydrogen sulfate 7 [2] (d) Identify solution **R**. ammonium ~~carbonate~~ sulfite 8 [2] [Total: 16]	Mark awarded for (b) (iii) = 1 out of 2 6 The formation of precipitates in (ii) and (iii) is not recorded. Mark awarded for (b) (iv) = 0 out of 1 7 Solution Q is sulfuric acid. Hydrogen sulfate is allowed as an alternative name. Mark awarded for (c) = 2 out of 2 8 Solution R is aqueous calcium hydroxide. This is a guessed answer. Incorrect observations made earlier in the question lead to this error. Mark awarded for (d) = 0 out of 2 **Total mark awarded = 8 out of 16**

How the candidate could have improved the answer

Greater clarity and detail were needed when recording observations of tests carried out.

Example Candidate Response – Question 2, Low	Examiner comments

2 You are provided with two solutions, solution **Q** and solution **R**.
Carry out the following tests on solution **Q** and solution **R**, recording all of your observations at each stage.

tests on solution Q

(a) Divide solution **Q** into four equal portions in four test-tubes. Carry out the following tests.

(i) Use pH indicator paper to measure the pH of the first portion of solution **Q**.

pH ~~4~~ 2 (1) [1]

(ii) Add a 2 cm strip of magnesium ribbon to the second portion of solution **Q**. Test the gas given off.
Record your observations.

Tested for hydrogen and popping (2) sound was heard. Hydrogen is given off [2]

(iii) Add a spatula measure of sodium carbonate to the third portion of solution **Q**. Test the gas given off.
Record your observations.

Tested for oxygen with a glowing (3) splint and the splint relighted. Oxygen is present [2]

(iv) Add a few drops of dilute nitric acid and about 1 cm^3 of aqueous barium nitrate to the fourth portion of solution **Q**.
Record your observations.

Milky precipitate forms on top and when mixed becomes a solution (4) [1]

tests on solution R

(b) Divide solution **R** into four equal portions in four test-tubes. Carry out the following tests.

(i) Measure the pH of the first portion of solution **R**.

pH 12 (5) [1]

(ii) Add several drops of aqueous sodium hydroxide to the second portion of solution **R** and shake the test-tube.
Then add excess aqueous sodium hydroxide to the test-tube.
Record your observations.

Nothing happens / No reaction (6) [2]

---

(1) Solution Q is sulfuric acid. pH is in the correct range (0–3).

Mark awarded for (a) (i) = 1 out of 1

(2) The candidate does not record the observation that the mixture fizzes/bubbles. A test result is given but the test using a lighted splint is not given.

Mark awarded for (a) (ii) = 0 out of 2

(3) No observation is given. The candidate shows a lack of knowledge and understanding – the gas tested is thought to be oxygen instead of carbon dioxide.

Mark awarded for (a) (iii) = 0 out of 2

(4) The vague description of a milky precipitate instead of a white precipitate is penalised.

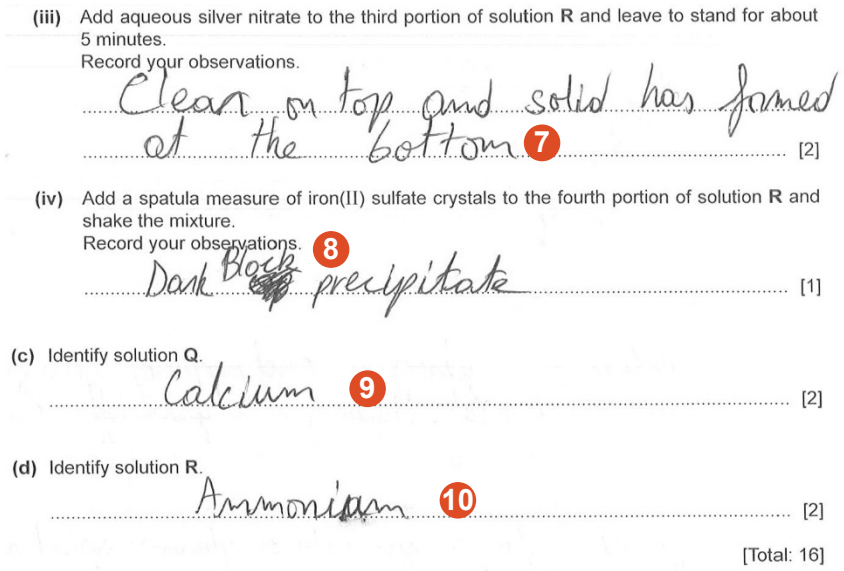
Mark awarded for (a) (iv) = 0 out of 1

(5) Solution R is aqueous calcium hydroxide and a pH in the allowed range (10–14) gained credit.

Mark awarded for (b) (i) = 1 out of 1

(6) The formation of a white precipitate which does not dissolve in excess aqueous sodium hydroxide is the expected observation.

Mark awarded for (b) (ii) = 0 out of 2

Example Candidate Response – Question 2, Low	Examiner comments
	7 The candidate recognises the formation of a solid but no colour is described. No credit is given as a brown precipitate is not described. Mark awarded for (b) (iii) = 0 out of 2 8 The formation of a precipitate is recorded but the colour is described as black instead of green. Mark awarded for (b) (iv) = 0 out of 1 9 The candidate is unable to conclude that an acid is present despite the correct result for the test in (a) (i). Mark awarded for (c) = 0 out of 2 10 The presence of hydroxide ions has not been inferred from the test in (b) (i). Mark awarded for (d) = 0 out of 2 **Total mark awarded = 2 out of 16**

How the candidate could have improved the answer

The candidate needed to describe the tests carried out as well as the results obtained from the tests.

The candidate showed a lack of knowledge and understanding.

Common mistakes candidates made in this question

- Making careless observations lacking the detail necessary to correlate with the marks allocated.
- Not using the practical notes provided to identify substances from the results obtained from the tests.

Question 3

Example Candidate Response – Question 3, High	Examiner comments

3 A liquid cleaner is a mixture of three substances. These substances are shown in the table.

name of substance	properties of substance
water	liquid, boiling point 100 °C
sodium carbonate	solid, soluble in water
silica	solid, insoluble in water

Plan experiments to obtain separate pure samples of each substance from the mixture in the liquid cleaner. You are provided with common laboratory apparatus.

~~1) Divide 1) Pour 30 cm³ of liquid~~
1) Measure 30 cm³ of liquid cleaner using a burette and pour it into an ~~evaporating dish~~ flask with a condenser on top
2) Heat it till 100°C. Condense the gas given off.
3) After condensation has occured add ~~to~~ anhydrous copper (II) sulfate ~~to measure~~ to the ~~liquid~~ gas condensed (liquid). ~~If it~~ the solution goes blue, then the solution is pure water.
~~4) Now there are 2 substance left in the liquid~~

[6]

[Total: 6]

1) Measure 30 cm³ of liquid cleaner using a burette.
2) Pour it into a funnel with filter paper and collect the left over in a ~~beaker~~ flask.
~~3) The residue left is the silica,~~
3) Take the residue off the filter paper, which is silica.
4) On top of the flask attach a condenser pipe and heat the flask till 100°C and condense the gas using ice. Have a thermometer to measure the temprature inside the flask.
5) Test the condensed gas (liquid) ~~with~~ by adding anhydrous copper (II) sulfate, if the solution changes to ~~butter~~ blue then that means it is pure water.
~~6) There must be crystals formed on the flask too~~ Continued on Pg 8

Q3) 6) There must be crystals formed in the flask ~~to~~, wait for it to cool ~~down~~ down, that is ~~Sodium Carbonate~~ pure Sodium carbonate.
~~7)~~ ~~Don~~

1 Silica is separated by filtration.

2 Water obtained by heating and condensing vapour scores both marks.

3 Sodium carbonate is separated out as crystals after cooling.

Total mark awarded = 5 out of 6

How the candidate could have improved the answer

The silica was separated by filtration. However, the candidate failed to purify the silica by washing it with water and then drying.

Example Candidate Response – Question 3, Middle	Examiner comments

3 A liquid cleaner is a mixture of three substances. These substances are shown in the table.

name of substance	properties of substance
water	liquid, boiling point 100 °C
sodium carbonate	solid, soluble in water
silica	solid, insoluble in water

Plan experiments to obtain separate pure samples of each substance from the mixture in the liquid cleaner. You are provided with common laboratory apparatus.

Step 1: Boil off the wate By using a bunsen and solution in a beaker. Collect the gas.
Step 2: Mix the remande with wate than filter using filte paper and a funnel. The solid will be the silica
Step 3: again boil off the remaining liquid to obtain the sodium carbonate
Step 4: Cool down the gas collected in step 1 to obtain the water

[6]

[Total: 6]

1 Silica is obtained from the mixture by filtration. The idea of purifying the silica by washing it with water and then drying the residue is not realised.

2 Sodium carbonate is separated by evaporation.

3 The candidate separates the water successfully in Steps 1 and 2.

Total mark awarded = 4 out of 6

How the candidate could have improved the answer

The silica was separated by filtration. However, the candidate failed to purify the silica by washing it with water and then drying.

Example Candidate Response – Question 3, Low	Examiner comments
3 A liquid cleaner is a mixture of three substances. These substances are shown in the table. name of substance / properties of substance water / liquid, boiling point 100 °C sodium carbonate / solid, soluble in water silica / solid, insoluble in water Plan experiments to obtain separate pure samples of each substance from the mixture in the liquid cleaner. You are provided with common laboratory apparatus. Filter the liquid cleaner to get the silica out of the mixture. Then use the distillation method to separate the water from the soluble sodium carbonate. Filtration method then simple distillation is the way to separate all of the substances 1 [6] [Total: 6]	1 The candidate separates the silica from the mixture but does not purify it by washing with water and drying. Distillation separates the water. There is no detail as to how the sodium carbonate is obtained. **Total mark awarded = 3 out of 6**

How the candidate could have improved the answer

The silica was separated by filtration. However, the candidate failed to purify the silica by washing it with water and then drying.

The candidate failed to separate the sodium carbonate from the mixture.

Common mistakes candidates made in this question

- Failing to purify the silica obtained from filtration.
- Separating the water successfully by heating the mixture but not mentioning condensing/cooling the vapour to obtain the liquid.

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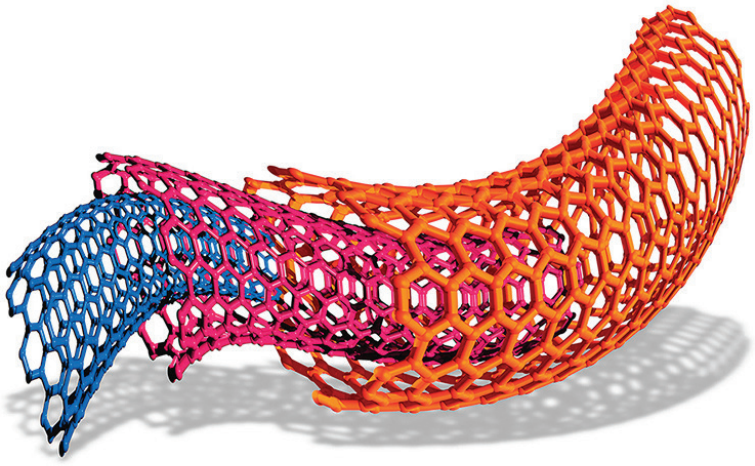
Example Candidate Responses
Paper 6

Cambridge IGCSE™
Chemistry 0620



Version 2.0

Cambridge Pathway

In order to help us develop the highest quality resources, we are undertaking a continuous programme of review; not only to measure the success of our resources but also to highlight areas for improvement and to identify new development needs.

We invite you to complete our survey by visiting the website below. Your comments on the quality and relevance of our resources are very important to us.

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Would you like to become a Cambridge International consultant and help us develop support materials?

Please follow the link below to register your interest.

www.cambridgeinternational.org/cambridge-for/teachers/teacherconsultants/

Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching IGCSE Chemistry (0620), and to show how different levels of candidates' performance (high, middle and low) relate to the subject's curriculum and assessment objectives.

In this booklet candidate responses have been chosen to exemplify a range of answers. Each response is accompanied by a brief commentary explaining the strengths and weaknesses of the answers.

For each question, response is annotated with clear explanation of where and why marks were awarded or omitted. This, in turn, is followed by examiner comments on how the answer could have been improved. In this way it is possible for you to understand what candidates have done to gain their marks and what they will have to do to improve their marks. At the end there is a list of common mistakes candidates made in their answers for each question.

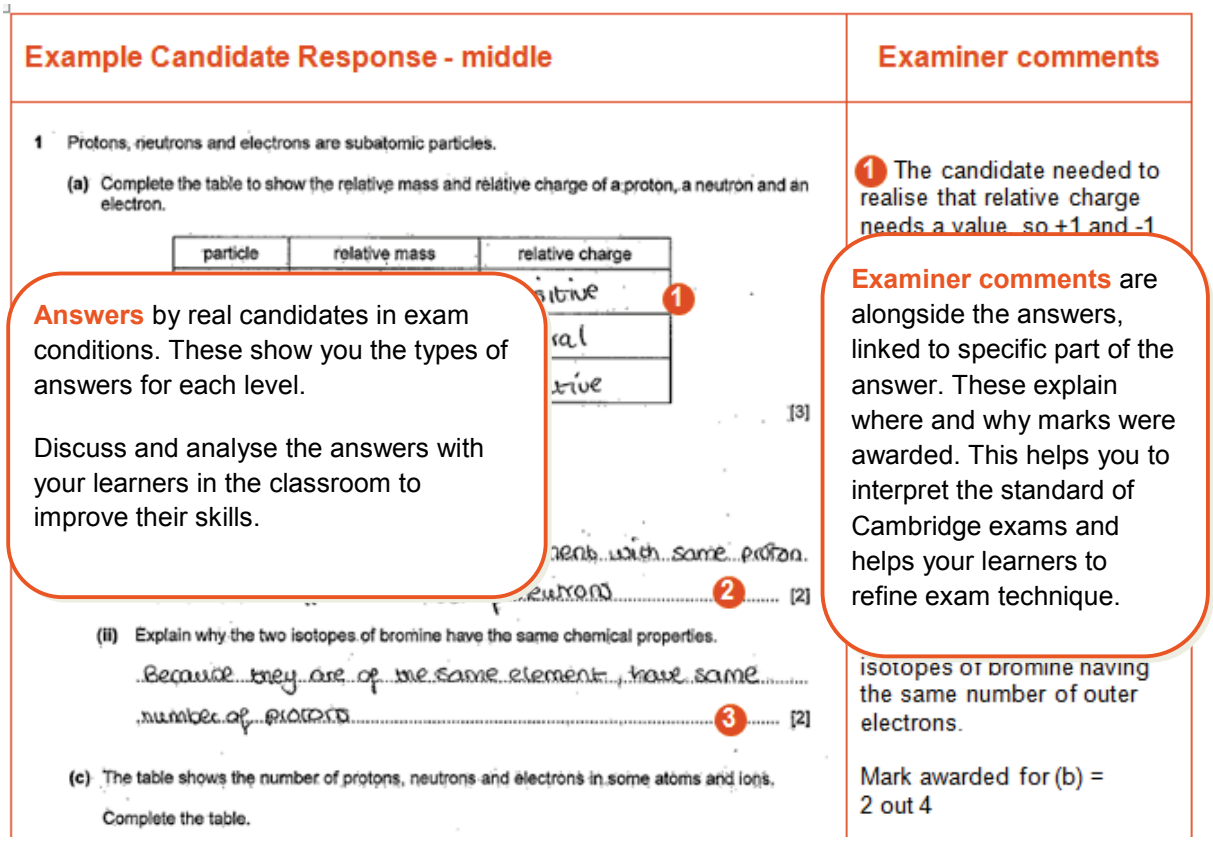
This document provides illustrative examples of candidate work. These help teachers to assess the standard required to achieve marks, beyond the guidance of the mark scheme. Some question types where the answer is clear from the mark scheme, such as short answers and multiple choice, have therefore been omitted.

The questions, mark schemes and pre-release material used here are available to download from the School Support Hub. These files are:

Question Paper 31, June 2016	
Question paper	0620_s16_qp_31.pdf
Mark scheme	0620_s16_ms_31.pdf
Question Paper 41, June 2016	
Question paper	0620_s16_qp_41.pdf
Mark scheme	0620_s16_ms_41.pdf
Question Paper 61, June 2016	
Question paper	0620_s16_qp_61.pdf
Mark scheme	0620_s16_ms_61.pdf

Other past papers, Examiner Reports and other teacher support materials are available on the School Support Hub at www.cambridgeinternational.org/support

How to use this booklet



Example Candidate Response - middle

Examiner comments

1 Protons, neutrons and electrons are subatomic particles.

(a) Complete the table to show the relative mass and relative charge of a proton, a neutron and an electron.

particle	relative mass	relative charge
		itive
		ral
		tive

[3]

(ii) Explain why the two isotopes of bromine have the same chemical properties.

Because they are of the same element, have same number of protons [2]

(c) The table shows the number of protons, neutrons and electrons in some atoms and ions.

Complete the table.

1 The candidate needed to realise that relative charge needs a value, so +1 and -1

isotopes of bromine having the same number of outer electrons.

Mark awarded for (b) = 2 out 4

Answers by real candidates in exam conditions. These show you the types of answers for each level.

Discuss and analyse the answers with your learners in the classroom to improve their skills.

Examiner comments are alongside the answers, linked to specific part of the answer. These explain where and why marks were awarded. This helps you to interpret the standard of Cambridge exams and helps your learners to refine exam technique.

How the candidate could have improved the answer

(b) (ii) The candidate needed to realise than positive and negative for proton an

(c) The candidate failed to include the m

This explains how the candidate could have improved the answer. This helps you to interpret the standard of Cambridge exams and helps your learners to refine exam technique.

Common mistakes candidates made in this question

(a) Failing to give *relative* masses and *relative* cha

(b) (i) Failing to recall that isotopes are *atoms*.

(b) (ii) Failing to state that it is the number of outer

This describes the common mistakes candidates made in answering each question. This will help your learners to avoid these mistakes at the exam and give them the best chance of achieving a high mark.

Assessment at a glance

All candidates must enter for three papers.

Core candidates take:	Extended candidates take:
Paper 1 45 minutes A multiple-choice paper consisting of 40 items of the four-choice type. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Core syllabus content. This paper will be weighted at 30% of the final total mark.	**Paper 2** 45 minutes A multiple-choice paper consisting of 40 items of the four-choice type. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Extended syllabus content (Core and Supplement). This paper will be weighted at 30% of the final total mark.
and:	**and:**
Paper 3 1 hour 15 minutes A written paper consisting of short-answer and structured questions. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Core syllabus content. 80 marks This paper will be weighted at 50% of the final total mark.	**Paper 4** 1 hour 15 minutes A written paper consisting of short-answer and structured questions. This paper will test assessment objectives AO1 and AO2. Questions will be based on the Extended syllabus content (Core and Supplement). 80 marks This paper will be weighted at 50% of the final total mark.

All candidates take	
either:	**or:**
Paper 5 1 hour 15 minutes Practical Test This paper will test assessment objective AO3. Questions will be based on the experimental skills in Section 7. The paper is structured to assess grade ranges A*–G. 40 marks This paper will be weighted at 20% of the final total mark.	**Paper 6** 1 hour Alternative to Practical This paper will test assessment objective AO3. Questions will be based on the experimental skills in Section 7. The paper is structured to assess grade ranges A*–G. 40 marks This paper will be weighted at 20% of the final total mark.

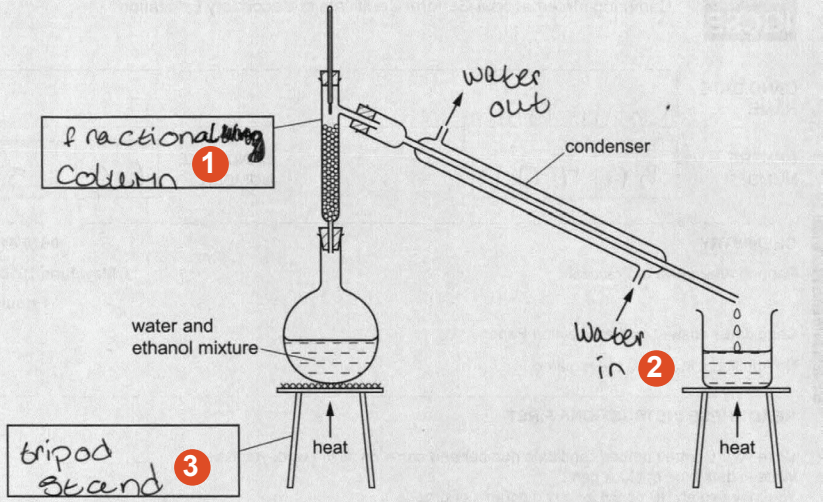
Teachers are reminded that the latest syllabus is available on our public website at www.cambridgeinternational.org and the School Support Hub at www.cambridgeinternational.org/support

Paper 6 – Alternative to Practical

Question 1

Example Candidate Response – Question 1, High	Examiner comments

1 The diagram shows the apparatus used to separate a mixture of water, boiling point 100 °C, and ethanol, boiling point 78 °C.



(a) Complete the boxes to name the apparatus. [2]

(b) Label the arrows on the condenser. [1]

(c) Identify **one** mistake in the apparatus.

applying heat to beaker 4 [1]

(d) Which liquid would collect first? Explain your answer.

ethanol water's
water; its boiling point is lower than ethanols,
boiling point
~~was 100°C for other boiling points were higher~~ 5 [2]

(e) Why would it be better to use an electrical heater instead of a Bunsen burner to heat the water and ethanol mixture?

ethanol is flammable 6 [1]

[Total: 7]

1 The mark scheme has 'fractionating column' but the answer given is close enough to score a mark

2 'Water' is all that was required for each of these labels, but the answers given are still better.

3 The word 'tripod' alone scores the mark but the word 'stand' alone would not.

Mark awarded for (a) =
2 out of 2

Mark awarded for (b) =
1 out of 1

4 The candidate does not use the wording in the mark scheme, but it is clear from their answer that they understand this.

Mark awarded for (c) =
1 out of 1

5 An incorrect answer has been crossed out and replaced with the correct one. It is important that incorrect answers are completely deleted by candidates. If two conflicting answers are given, no marks are scored.

Mark awarded for (d) =
2 out of 2

6 Almost the exact words on the mark scheme. It was not necessary for the candidate to state that an electrical heater would avoid the risk of fire.

Mark awarded for (e) =
1 out of 1

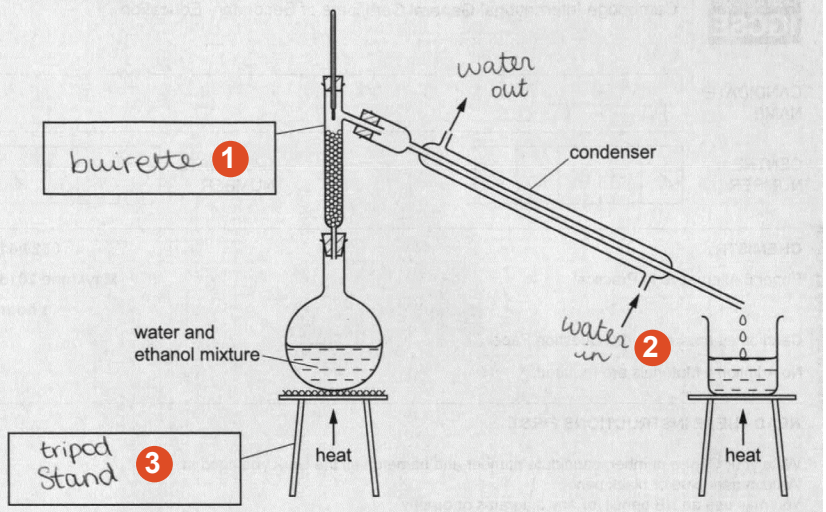
Total mark awarded =
7 out of 7

How the candidate could have improved the answer

(a) The correct name is ‘fractionating column’ but the answer given was close enough for a mark. The word ‘stand’ with ‘tripod’ was not really necessary.

Example Candidate Response – Question 1, Middle

1 The diagram shows the apparatus used to separate a mixture of water, boiling point 100 °C, and ethanol, boiling point 78 °C.



(a) Complete the boxes to name the apparatus. [2]

(b) Label the arrows on the condenser. [1]

(c) Identify **one** mistake in the apparatus.

heat applied to condensed liquid 4 [1]

(d) Which liquid would collect first? Explain your answer.

ethanol , it has a lower boiling point 5

[2]

(e) Why would it be better to use an electrical heater instead of a Bunsen burner to heat the water and ethanol mixture?

you can choose the exact temperature 6 [1]

[Total: 7]

Examiner comments

1 The candidate gives the name of a piece of apparatus with a similar shape but is clearly not familiar with the name specified in the mark scheme.

2 No problems here. The word 'water' would have sufficed but there is nothing wrong with the answer given. Simply labelling 'in' and 'out' would not have scored marks.

3 The word 'stand' is superfluous and would not have scored marks if used alone.

Mark awarded for (a) =
1 out of 2

Mark awarded for (b) =
1 out of 1

4 The mark scheme has 'heat applied under the beaker', but, since the beaker contains the condensed liquid, it is clear what the candidate means and the answer is still judged to be correct.

Mark awarded for (c) =
1 out of 1

5 A straightforward answer which almost exactly matches the mark scheme.

Mark awarded for (d) =
2 out of 2

6 It is true that an electrical heater allows the choice of a particular temperature. This is, however, not important in this experiment and it is not the reason given in the mark scheme.

Mark awarded for (e) =
0 out of 1

Total mark awarded =
5 out of 7

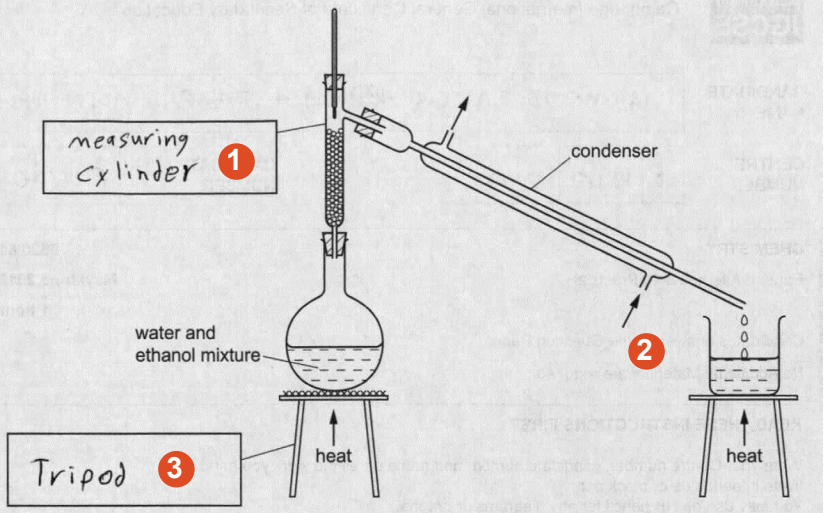
How the candidate could have improved the answer

(a) The piece of apparatus looks similar to a burette but isn't one. The candidate needed to give the correct name here.

(c) The candidate should have used the wording in the mark scheme which has 'heat applied under the beaker' or something similar, but, since the beaker contains the condensed liquid, this answer was allowed.

Example Candidate Response – Question 1, Low

1 The diagram shows the apparatus used to separate a mixture of water, boiling point 100 °C, and ethanol, boiling point 78 °C.



(a) Complete the boxes to name the apparatus. [2]

(b) Label the arrows on the condenser. [1]

(c) Identify **one** mistake in the apparatus. [1]

~~Water and ethanol mixture~~ Heat applied on collecting burrette. ~~Heat in the~~ 4

(d) Which liquid would collect first? Explain your answer. [2]

Water, because it will get seperated from ethanol. 5

(e) Why would it be better to use an electrical heater instead of a Bunsen burner to heat the water and ethanol mixture? [1]

For accurate heating. 6

[Total: 7]

Examiner comments

1 The candidate appears not to know the name of this piece of apparatus, perhaps because they haven't seen or done this experiment.

2 No answer given here. Candidates sometimes fail to answer questions which do not involve writing an answer on a line.

3 Correct and to the point.

Mark awarded for (a) =
1 out of 2

Mark awarded for (b) =
0 out of 1

4 Here the candidate has deleted a correct answer only to replace it with a wrong one. The use of the word 'burette' makes it wrong even though the word 'collecting' has been added. It is not wise for candidates to use words which they don't understand.

Mark awarded for (c) =
0 out of 1

5 The initial answer is wrong here, and so the reason, although there is some truth in it, cannot be correct either. Again, the candidate appears to be unfamiliar with this experiment.

Mark awarded for (d) =
0 out of 2

6 An electrical heater may result in 'accurate heating' but this is not the reason why it is used in this case.

Mark awarded for (e) =
0 out of 1

Total mark awarded =
1 out of 7

How the candidate could have improved the answer

The candidate was clearly unfamiliar with this experiment. It is in the syllabus and it is essential that candidates attempting this paper have had experience of practical work. This paper is NOT an alternative to practical work but an alternative way of assessing practical work.

Common mistakes candidates made in this question

(e) The commonest wrong answer to this question was stating that the electrical heater was used to provide accurate heating, rather than because ethanol is flammable.

Question 2

Example Candidate Response – Question 2, High	Examiner comments

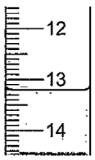
2 A student investigated the reaction between aqueous sodium carbonate and two different solutions of dilute hydrochloric acid, **A** and **B**.
The reaction is:

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

Three experiments were carried out.

(a) *Experiment 1*

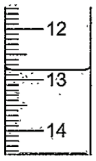
Using a measuring cylinder, 25 cm^3 of aqueous sodium carbonate were poured into a conical flask.
Thymolphthalein indicator was added to the conical flask.
A burette was filled up to the 0.0 cm^3 mark with solution **A** of dilute hydrochloric acid. **A** was added to the flask, until the solution just changed colour.
Use the burette diagram to record the reading in the table.



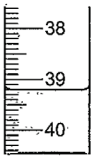
final reading

Experiment 2

Experiment 1 was repeated using methyl orange indicator instead of thymolphthalein.
Methyl orange is red-orange in acidic solutions and yellow in alkaline solutions.
Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

	experiment 1	experiment 2
final burette reading / cm^3	13.2	39.2
initial burette reading / cm^3	0.0	12.8
difference / cm^3	13.2	26.4

[4]

Mark awarded for (a) = 4 out of 4

Example Candidate Response – Question 2, High	Examiner comments

(b) What colour change was observed in the flask in experiment 2?

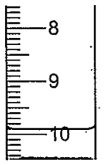
from ..yellow.. to ..orange.. [1]

Mark awarded for (b) = 1 out of 1

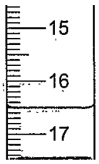
(c) *Experiment 3*

Experiment 1 was repeated using solution **B** of acid instead of solution **A**.

Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

	experiment 3
final burette reading / cm³	16.5
initial burette reading / cm³	9.9
difference / cm³	6.6

[2]

Mark awarded for (c) = 2 out of 2

(d) Suggest **one** observation, other than colour change, that is made when hydrochloric acid is added to sodium carbonate.

..Effervescence and bubbles of a colourless gas.. (carbon dioxide) [1]

Mark awarded for (d) = 1 out of 1

(e) Complete the sentence below.

Experiment ..2.. needed the largest volume of hydrochloric acid to change the colour of the indicator. [1]

Mark awarded for (e) = 1 out of 1

(f) What would be a more accurate method of measuring the volume of the aqueous sodium carbonate?

..using a burette.. [1]

Mark awarded for (f) = 1 out of 1

1 Parts (a) to (f) are all correct.

Example Candidate Response – Question 2, High

(g) What would be the effect on the results, if any, if the solutions of sodium carbonate were warmed before adding the hydrochloric acid? Give a reason for your answer.

effect on results ..... ~~decrease~~ NO change .....

reason ..... the heard to decompose sodium (reactive metal) ..... [2]

(h) (i) Determine the ratio of volumes of dilute hydrochloric acid used in experiments 1 and 3.

..... Experiment 3 used double volume of experiment 2 ~~1:1~~ 2:1 [1]

(ii) Use your answer to **(h)(i)** to deduce how the concentration of solution **A** differs from that of solution **B**.

..... solution A is more concentrated (double) than solution B [1]

(i) Suggest a **different** method, using standard laboratory chemicals, to determine which of the solutions of dilute hydrochloric acid, **A** or **B**, is more concentrated.

..... Using the same mass and particle size of a reactive metal (e.g. magnesium), add each to a separate conical flask. Add a known volume of solution A (25cm³) to the first conical flask and measure the rate of gas (hydrogen) production over a period of time, repeat with solution B (same volume of 25cm³) in the other flask, measure the rate of gas production over the same time, compare. One that produced more gas at time interval has more concentrated acid solution. [3]

[Total: 17]

Examiner comments

2 'No change' is correct but the reason given does not really apply. The candidate is perhaps implying that the concentration of the carbonate is not changed as a result, but this is not explicit.

Mark awarded for (g) =
1 out of 2

3 The candidate gives the ratio as 2:1 but an answer written as words would still have scored the mark.

4 The candidate has spotted that this means a twofold difference in concentrations but, unfortunately, has not thought this through and gives the wrong acid as the more concentrated.

Mark awarded for (h) =
1 out of 2

5 Correct reactants.

6 There is nothing about how the rate will be measured: timing, counting bubbles, etc.
One mark lost.

7 The candidate fails to explain a way to determine which solution is the more concentrated.

Mark awarded for (i) =
2 out of 3

Total mark awarded =
14 out of 17

How the candidate could have improved the answer

(g) The candidate could have improved their answer by giving the correct reason here. The answer included a correct chemical concept but it was not relevant to this problem.

(h) (ii) It is quite a common error to conclude that if more of a solution is used, it is more concentrated, whereas the opposite is the case.

(i) The candidate should have included more detail, in what was a correct answer, to gain full marks.

Example Candidate Response – Question 2, Middle

Examiner comments

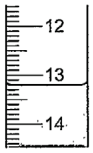
2 A student investigated the reaction between aqueous sodium carbonate and two different solutions of dilute hydrochloric acid, **A** and **B**.
The reaction is:

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

Three experiments were carried out.

(a) *Experiment 1*

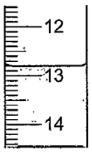
Using a measuring cylinder, 25 cm^3 of aqueous sodium carbonate were poured into a conical flask.
Thymolphthalein indicator was added to the conical flask.
A burette was filled up to the 0.0 cm^3 mark with solution **A** of dilute hydrochloric acid. **A** was added to the flask, until the solution just changed colour.
Use the burette diagram to record the reading in the table.



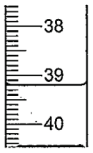
final reading

Experiment 2

Experiment 1 was repeated using methyl orange indicator instead of thymolphthalein.
Methyl orange is red-orange in acidic solutions and yellow in alkaline solutions.
Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

	experiment 1	experiment 2
final burette reading / cm^3	14.8 cm^3	40.8 cm^3
initial burette reading / cm^3	0.0 cm^3	13.2 cm^3
difference / cm^3	14.8 cm^3	27.6 cm^3

[4]

1 The candidate is reading the scales as if they were measuring cylinders and clearly hasn't looked at the next main division in either case. Only the differences are correct.

Mark awarded for (a) = 2 out of 4

Example Candidate Response – Question 2, Middle

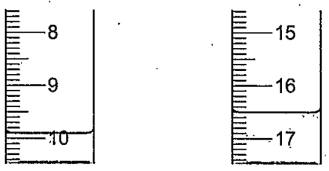
(b) What colour change was observed in the flask in experiment 2?

from ..yellow.. to ..red-orange.. [1]

(c) *Experiment 3*

Experiment 1 was repeated using solution **B** of acid instead of solution **A**.

Use the burette diagrams to record the readings in the table and complete the table.



initial reading final reading

	experiment 3
final burette reading/cm³	17.6cm³ ~~10.1~~
initial burette reading/cm³	10.1 cm³
difference/cm³	7.4cm³

[2]

(d) Suggest **one** observation, other than colour change, that is made when hydrochloric acid is added to sodium carbonate.

..a gas is formed.. [1]

(e) Complete the sentence below.

Experiment ..2.. needed the largest volume of hydrochloric acid to change the colour of the indicator. [1]

(f) What would be a more accurate method of measuring the volume of the aqueous sodium carbonate?

..using a volumetric pipette.. [1]

Examiner comments

2 Correct.

Mark awarded for (b) = 1 out of 1

3 Same error as in part (a).

Mark awarded for (c) = 1 out of 2

4 True, but no marks are scored here as this is not an observation. How would the gas be seen?

Mark awarded for (d) = 0 out of 1

Mark awarded for (e) = 1 out of 1

Mark awarded for (f) = 1 out of 1

Example Candidate Response – Question 2, Middle	Examiner comments
(g) What would be the effect on the results, if any, if the solutions of sodium carbonate were warmed before adding the hydrochloric acid? Give a reason for your answer. effect on results The reaction would be fast. reason There are particles with the activation energy 5 [2] **(h) (i)** Determine the ratio of volumes of dilute hydrochloric acid used in experiments 1 and 3. 2 : 1 [1] **(ii)** Use your answer to **(h)(i)** to deduce how the concentration of solution **A** differs from that of solution **B**. Solution A is twice the concentration of solution B 6 [1] **(i)** Suggest a **different** method, using standard laboratory chemicals, to determine which of the solutions of dilute hydrochloric acid, **A** or **B**, is more concentrated. You could react it with a base. You let take 20mg of Sodium Carbonate and then add 5a 40cm³ of Sample A of an HCl 7 and then note the time. You repeat this for the other sample of the acid 8 bu then Compare the time, so that the fastest is more Concentrated than the other One. 9 [3] [Total: 17]	5 A common wrong answer. The candidate knows the reaction would speed up and explains why, but does not state how the result (i.e. the volumes measured) would be affected. Mark awarded for (g) = 0 out of 2 6 The ratio in part (i) is correct but this result is misinterpreted. Only 1 mark. Mark awarded for (h) = 1 out of 2 7 These are correct reactants as a titration is not being used. 8 'Note the time' for what? No marks here. If 'bubbles collecting a gas' or 'waiting till effervescence stops' had been mentioned the answer would have scored full marks. 9 This is a correct way of deciding which is more concentrated. Mark awarded for (i) = 2 out of 3 **Total mark awarded = 9 out of 17**

How the candidate could have improved the answer

(a) and **(c)** The candidate read the scales as if they were using a measuring cylinder. A closer look at the values given on the scales would have made this careless error obvious.

(d) The candidate's answer was factually correct but did not constitute an observation, just a fact. The candidate needed to say how the gas would be seen.

(g) Again the candidate's answer was true, but this speeding-up would not affect the final results. The candidate needed to say how the result (i.e. the volumes measured) would be affected.

(h) (ii) The same error as the highest scoring candidate.

(i) A correct answer but not containing sufficient detail to score full marks. The candidate needed to mention 'bubbles collecting a gas' or 'waiting till effervescence stopped'.

Example Candidate Response – Question 2, Low

Examiner comments

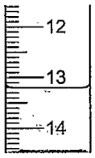
2 A student investigated the reaction between aqueous sodium carbonate and two different solutions of dilute hydrochloric acid, **A** and **B**.
The reaction is:

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

Three experiments were carried out.

(a) *Experiment 1*

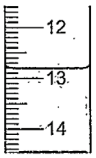
Using a measuring cylinder, 25 cm^3 of aqueous sodium carbonate were poured into a conical flask.
Thymolphthalein indicator was added to the conical flask.
A burette was filled up to the 0.0 cm^3 mark with solution **A** of dilute hydrochloric acid. **A** was added to the flask, until the solution just changed colour.
Use the burette diagram to record the reading in the table.



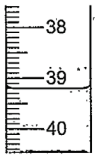
final reading

Experiment 2

Experiment 1 was repeated using methyl orange indicator instead of thymolphthalein.
Methyl orange is red-orange in acidic solutions and yellow in alkaline solutions.
Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

	experiment 1	experiment 2
final burette reading / cm^3	13.2	39.2
initial burette reading / cm^3	0	12.8
difference / cm^3	13.2	26.4

[4]

1 Correct readings are given here, but the lack of the .0 in the initial reading for experiment 1 loses a mark.

Mark awarded for (a) =
3 out of 4

Example Candidate Response – Question 2, Low

(b) What colour change was observed in the flask in experiment 2?

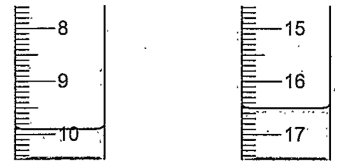
from ..Red - orange.. to ..Yellow.. [1]

2

(c) *Experiment 3*

Experiment 1 was repeated using solution **B** of acid instead of solution **A**.

Use the burette diagrams to record the readings in the table and complete the table.



initial reading final reading

	experiment 3
final burette reading / cm³	16.5
initial burette reading / cm³	9.9
difference / cm³	6.6

[2]

(d) Suggest **one** observation, other than colour change, that is made when hydrochloric acid is added to sodium carbonate.

..(Fizz) Bubbles are formed.. [1]

(e) Complete the sentence below.

Experiment ..3.. needed the largest volume of hydrochloric acid to change the colour of the indicator. [1]

3

(f) What would be a more accurate method of measuring the volume of the aqueous sodium carbonate?

..~~Measuring cylinder~~ Pipette.. [1]

4

Examiner comments

2 This is the correct colour change but in the wrong direction, so no mark.

Mark awarded for (b) = 0 out of 1

Mark awarded for (c) = 2 out of 2

Mark awarded for (d) = 1 out of 1

3 It is not clear why the candidate has chosen experiment 3 as the answer here.

Mark awarded for (e) = 0 out of 1

4 The candidate has realised that a measuring cylinder would have been less accurate here.

Mark awarded for (f) = 1 out of 1

Example Candidate Response – Question 2, Low

(g) What would be the effect on the results, if any, if the solutions of sodium carbonate were warmed before adding the hydrochloric acid? Give a reason for your answer.

effect on results ..... Different temperature

reason ..... the sodium carbonate ~~is should be eat~~ will react faster

5 [2]

(h) (i) Determine the ratio of volumes of dilute hydrochloric acid used in experiments 1 and 3.

19.8 6 [1]

(ii) Use your answer to **(h)(i)** to deduce how the concentration of solution **A** differs from that of solution **B**.

The ratio of ~~B~~ solution A is higher and more concentrated. 7 [1]

(i) Suggest a **different** method, using standard laboratory chemicals, to determine which of the solutions of dilute hydrochloric acid, **A** or **B**, is more concentrated.

Using ~~Conical flask~~ Burrette and thymolphthalein indicator and ~~add~~ adding dilute ~~hydroc~~ hydrochloric acid and the more acidic solution is the more concentrated and we can know that by the red ~~or~~ ~~color~~ ~~orang~~ or orange color. 8 [3]

[Total: 17]

Examiner comments

5 The candidate has misunderstood the question.

Mark awarded for (g) =
0 out of 2

6 The candidate doesn't understand the concept of ratio and has simply added the two values together.

7 Again, the candidate doesn't understand about concentrations.

Mark awarded for (h) =
0 out of 2

8 This seems to be a mixture of two methods, neither of which merits marks. Using thymolphthalein as an indicator is just another titration, but towards the end the candidate seems to suggest using universal indicator to measure pH and thus identify the more concentrated solution. This just wouldn't work even if it were properly explained.

Mark awarded for (i) =
0 out of 3

Total mark awarded =
7 out of 17

How the candidate could have improved the answer

(a) The candidate did not give 0.0 as the initial reading.

(b) The candidate gave the correct colour change but the wrong way round.

(e) Since the candidate correctly identified all the volumes, it is unclear why they picked the wrong answer here.

(g) The candidate could have improved their answer by reading the question more carefully. The answer given just did not answer the question.

(h) The candidate clearly did not understand the meaning of 'ratio'.

(i) The candidate explained a method (titration) which is essentially the same as that originally used. A different method was requested.

Common mistakes candidates made in this question

(i) Many candidates suggested using the same method again with different substances. Candidates should understand that the method is independent of the substances used. A titration is always a titration.

Question 3

Example Candidate Response – Question 3, High

3 Two substances, **C** and **D**, were analysed. Solid **C** was a salt and solution **D** was an aqueous solution of chromium(III) chloride.
The tests on solid **C**, and some of the observations, are in the following table.

tests	observations
tests on solid **C** Solid **C** was added to distilled water in a test-tube and shaken to dissolve. The solution was divided into two portions in test-tubes, and the following tests carried out. Appearance of the solution. The pH of the first portion of the solution was tested.	 colourless liquid pH = 7
Dilute nitric acid was added to the second portion of the solution followed by aqueous silver nitrate.	cream precipitate
A flame test was carried out on solid **C**.	yellow flame colour

(a) Identify solid **C**.

Sodium Bromide 1 ..... [2]

(b) Describe the appearance of solution **D**.

green colour solution 2 ..... [1]

(c) Tests were carried out on solution **D**.

Complete the observations for tests 1, 2 and 3.

(i) test 1

Drops of aqueous sodium hydroxide were added to solution **D**.

Excess aqueous sodium hydroxide was then added to the mixture.

observations green precipitate soluble in excess so aqueous sodium hydroxide 3 ..... [3]

Examiner comments

1 A perfect answer. A correct chemical formula would also have gained full marks.
The marks are separate so either 'sodium' or 'bromide' alone or coupled with another ion would gain a single mark.
Mark awarded for (a) =
2 out of 2

2 'Chromium' is not in the main body of the syllabus. This is a practical paper and any candidate who has done the ion tests would, like this candidate, know the correct answer.

Mark awarded for (b) =
1 out of 1

3 Again a perfect answer, repeating what is included in the 'Tests for ions' section of the syllabus.

Example Candidate Response – Question 3, High	Examiner comments

(ii) test 2

Excess aqueous ammonia was added to solution **D**.

observations grey-green precipitate insoluble in excess [2] 4

(iii) test 3

Dilute nitric acid was added to solution **D** followed by aqueous silver nitrate.

observations White precipitate 5 [1]

(d) Chromium(III) can be converted to chromium(VI). Chromium(VI) is hazardous.

Suggest **one** safety precaution when using chromium(VI).

Wear gloves 6 [1]

[Total: 10]

NaOH — green ppt — soluble

NH₄OH — grey-green — insoluble

C — Salt soluble no transition bromide ion. Na

D — solution chromium(III) chloride 7

4 Here 'grey-green' is important as this is the description of the colour given in the syllabus.

5 A perfect answer.

Mark awarded for (c) = 6 out of 6

6 This is the best answer to this question, as chromium (VI) is harmful to the skin. However, as the candidate is not expected to know this, other safety precautions would also have been accepted.

Mark awarded for (d) = 1 out of 1

7 These notes from the candidate show how they made sure of getting their answers correct.

Total mark awarded = 10 out of 10

How the candidate could have improved the answer

This candidate achieved full marks.

Example Candidate Response – Question 3, Middle

Examiner comments

3 Two substances, **C** and **D**, were analysed. Solid **C** was a salt and solution **D** was an aqueous solution of chromium(III) chloride.
The tests on solid **C**, and some of the observations, are in the following table.

tests	observations
tests on solid **C** Solid **C** was added to distilled water in a test-tube and shaken to dissolve. The solution was divided into two portions in test-tubes, and the following tests carried out. Appearance of the solution. The pH of the first portion of the solution was tested.	 colourless liquid pH = 7
Dilute nitric acid was added to the second portion of the solution followed by aqueous silver nitrate.	cream precipitate
A flame test was carried out on solid **C**.	yellow flame colour

(a) Identify solid **C**.

bromide ion [2]

(b) Describe the appearance of solution **D**.

blue liquid [1]

(c) Tests were carried out on solution **D**.

Complete the observations for tests 1, 2 and 3.

(i) **test 1**

Drops of aqueous sodium hydroxide were added to solution **D**.

Excess aqueous sodium hydroxide was then added to the mixture.

observations green precipitate, which is soluble in excess [3]

1 The candidate gains a single mark for correctly identifying the bromide ion but has not taken account of the flame test which gives sodium as the other ion.

Mark awarded for (a) =
1 out of 2

2 If the candidate had carried out the ion tests described in the syllabus, they would know that the colour is green even though the metal chromium and its compounds are not mentioned elsewhere in the syllabus.

Mark awarded for (b) =
1 out of 1

3 The candidate has correctly learned this test and its result. Full marks.

Example Candidate Response – Question 3, Middle

(ii) **test 2**

Excess aqueous ammonia was added to solution **D**.

observations green precipitate which is insoluble [2]

4

(iii) **test 3**

Dilute nitric acid was added to solution **D** followed by aqueous silver nitrate.

observations White precipitate which is soluble [1]

5

(d) Chromium(III) can be converted to chromium(VI). Chromium(VI) is hazardous.

Suggest **one** safety precaution when using chromium(VI).

~~Using it in a fume cupboard and~~ wearing. [1]

gloves and goggles while using ~~it~~ it.

6

[Total: 10]

Examiner comments

4 The candidate knows this precipitate is insoluble and so gains one of the marks here. However, the 'Tests for ions' section of the syllabus describes the colour as grey-green and this was the description required to gain a mark.

5 The candidate knows that this test yields a white precipitate. However, they wrongly state that it is soluble and this cancels out the mark gained. Had the candidate simply stated 'white precipitate' they would have gained the mark. It is sometimes inadvisable to add unnecessary information.

Mark awarded for (c) =
4 out of 6

6 All of these answers are acceptable as a precaution (including the deleted one). 'Gloves' was the best answer because of the nature of the hazard.

Mark awarded for (d) =
1 out of 1

Total marks awarded =
7 out of 10

How the candidate could have improved the answer

(a) Solid C is a bromide but this is not a complete identification. The flame test should have told the candidate 'sodium' bromide.

(b) Solution D is indeed a liquid but a colour was also required here.

(c) (ii) The official description of this colour in the syllabus is 'grey-green'. This was the answer expected.

(c) (iii) The candidate correctly gave 'white precipitate' but this mark was cancelled out by the wrong statement that it was soluble. It was not necessary to state anything about solubility here, so if the candidate had not added these words, they would have gained the mark.

Example Candidate Response – Question 3, Low

Examiner comments

3 Two substances, **C** and **D**, were analysed. Solid **C** was a salt and solution **D** was an aqueous solution of chromium(III) chloride.
The tests on solid **C**, and some of the observations, are in the following table.

tests	observations
tests on solid **C** Solid **C** was added to distilled water in a test-tube and shaken to dissolve. The solution was divided into two portions in test-tubes, and the following tests carried out. Appearance of the solution. The pH of the first portion of the solution was tested.	 colourless liquid pH = 7
Dilute nitric acid was added to the second portion of the solution followed by aqueous silver nitrate.	cream precipitate
A flame test was carried out on solid **C**.	yellow flame colour

(a) Identify solid **C**.

~~Solid~~ Bromine 1 ..... [2]

(b) Describe the appearance of solution **D**.

Shiny 2 ..... [1]

(c) Tests were carried out on solution **D**.

Complete the observations for tests 1, 2 and 3.

(i) test 1

Drops of aqueous sodium hydroxide were added to solution **D**.

Excess aqueous sodium hydroxide was then added to the mixture.

observations becomes ~~green~~ ~~clear~~ more 3

Shiny ..... [3]

1 The candidate misses the importance of the flame test and loses the second mark by writing 'bromine', which is not the same as 'bromide', the bromine ion which the test shows.

Mark awarded for (a) =
0 out of 2

2 The candidate is clearly thinking of the metal chromium, not of the compound named.

Mark awarded for (b) =
0 out of 1

3 The mistake from part (b) is carried forward here. The candidate perhaps has no experience of testing for ions in a practical experiment.

Example Candidate Response – Question 3, Low	Examiner comments
(ii) test 2 Excess aqueous ammonia was added to solution **D**. observations Gets Soft 4 [2] **(iii) test 3** Dilute nitric acid was added to solution **D** followed by aqueous silver nitrate. observations 5 [1] **(d)** Chromium(III) can be converted to chromium(VI). Chromium(VI) is hazardous. Suggest **one** safety precaution when using chromium(VI). Safety goggles. 6 [1] [Total: 10]	4 The candidate has given a meaningless answer because they have no practical experience of this test. It is important that candidates attempting this paper have some experience of the practical part of the syllabus. 5 No answer offered. This is a very straightforward question for any candidate who has attempted this part of the practical syllabus. Mark awarded for (c) = 0 out of 6 6 This is a safety precaution and though it would not be of particular help in coping with this hazard it is worth a mark. Mark awarded for (d) = 1 out of 1 **Total mark awarded = 1 out of 10**

How the candidate could have improved the answer

(a) A careless mistake: the correct word to use is 'bromide'. 'Bromine' refers only to the element.

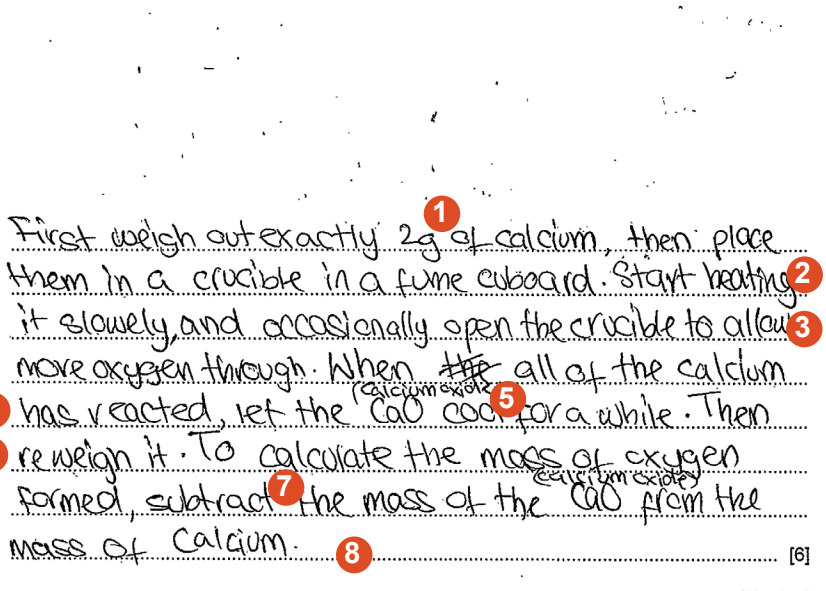
(b) and **(c)** The candidate was clearly thinking of the metal here, not about its compounds.

Knowledge of the tests for ions detailed in the syllabus would have enabled the candidate to score well in this answer.

Common mistakes candidates made in this question

A significant number of weaker candidates scored well on this question because they had learned the tests for different ions. It is essential that these are known and preferably experienced through practical experimentation by candidates.

Question 4

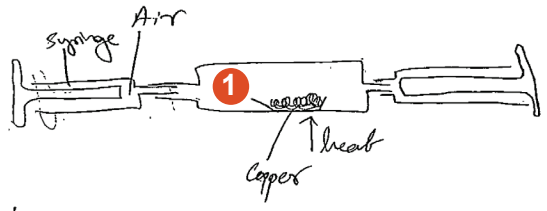
Example Candidate Response – Question 4, High	Examiner comments
4 Calcium burns in air to form calcium oxide. The reaction is vigorous and some of the calcium oxide can be lost as smoke. Plan an investigation to determine the maximum mass of oxygen that combines to form calcium oxide when 2g of calcium granules are burnt in air. You are provided with common laboratory apparatus and calcium granules.  First weigh out exactly 2g (1) of calcium, then place them in a crucible in a fume cupboard. Start heating (2) it slowly and occasionally open the crucible to allow (3) more oxygen through. When the (calcium oxide) all of the calcium has reacted (4), let the CaO cool (5) for a while. Then reweigh it (6). To calculate the mass of oxygen formed, subtract (7) the mass of the (calcium oxide) CaO from the mass of calcium. (8) [6] [Total: 6]	1 One mark awarded for weighing. 2 One mark awarded for heating the granules. 3 One mark awarded for allowing the entry of air here, but there is no mention of how the crucible is to be 'opened' (using a lid). 4 There is nothing about how the candidate will know when all the calcium oxide has reacted. 5 One mark awarded for allowing the calcium oxide to cool. 6 One mark awarded for reweighing the calcium oxide. 7 The candidate has made a mistake in calculating the mass of oxygen. 8 A good answer from a candidate who clearly knows the experiment and how to carry it out. However, some careless mistakes and omissions from the method mean that only 5 of the 6 marks are scored. **Total mark awarded = 5 out of 6**

How the candidate could have improved the answer

This was a good answer but the candidate lost a mark at the end as they subtracted the mass of the calcium oxide from the mass of calcium rather than the calcium from the calcium oxide. This careless mistake cost a mark.

Example Candidate Response – Question 4, Middle	Examiner comments

4 Calcium burns in air to form calcium oxide. The reaction is vigorous and some of the calcium oxide can be lost as smoke.
Plan an investigation to determine the maximum mass of oxygen that combines to form calcium oxide when 2 g of calcium granules are burnt in air.
You are provided with common laboratory apparatus and calcium granules.



2 take 2g of Calcium granules in dish Connect it to 2 air Syringes one of them must be filled with air then ~~be~~ put ethane 3 under the Copper and push the air from side to side by the syringes the Volume of air will start decreasing till specific Volume then you remove all the apparatus take the Calcium oxide after the reaction measure the mass then subtract it from 2g it will give you the mass of oxygen reacted with 2g of 4 5 Calcium use gloves and wear eye ~~goggles~~ goggles 6 [6]

[Total: 6]

1 The candidate is clearly thinking about the experiment to find the percentage of oxygen in air here and has even labelled the metal as copper.

2 One mark awarded for implying that 2g of calcium is weighed.

3 One mark is awarded for mentioning heating. (This mark is gained even though the candidate has again referred to the metal as copper.)

4 One mark awarded for reweighing the calcium oxide.

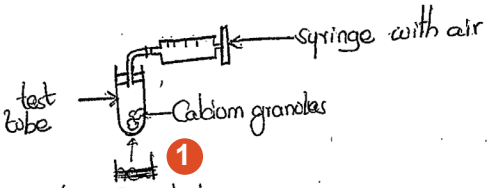
5 The candidate explains the final calculation incorrectly and so fails to earn this mark.

6 The candidate gives an incorrect method which would not work here. However, they score 3 marks overall and nearly gain 4.

Total mark awarded = 3 out of 6

How the candidate could have improved the answer

In this exercise the candidate needed to devise an experiment which they would not have carried out during their course, but which was based on one they were familiar with. If they had used a different experiment as the basis for their own method, they would have gained more marks.

Example Candidate Response – Question 4, Low	Examiner comments
4 Calcium burns in air to form calcium oxide. The reaction is vigorous and some of the calcium oxide can be lost as smoke. Plan an investigation to determine the maximum mass of oxygen that combines to form calcium oxide when 2 g of calcium granules are burnt in air. You are provided with common laboratory apparatus and calcium granules.  1 You can take a 50cm³ syringe and fill it in with air which contains oxygen. You take the Calcium granules and place them inside the test tube. You the starting releasing the air using a tube into the test to make sure there is no air already or no air comes in. You then wait for smoke to be produced and then you check the initial temperature of the air on the Cylinder and Compare it to the final [6] The volume you get you sublimate to a solid [Total: 6] and then you measure the mass of the solid. 2 3	1 Unfortunately, 'heat' has been crossed out here. This would have scored a mark. 2 A mark is awarded for measuring the mass of the solid produced. 3 The candidate only earns one mark for this answer and does not seem to know how such an experiment could be carried out. **Total mark awarded = 1 out of 6**

How the candidate could have improved the answer

The candidate had little idea of how to approach the task, and could have made better use of the information given in the question. For instance, it was clear that the calcium should be burnt in air. It was also clear that weighing before and after the experiment was necessary ('maximum mass of oxygen', '2 g of calcium granules').

Common mistakes candidates made in this question

Candidates are told in the question that some of the calcium oxide 'can be lost as smoke'. This was to prompt them to try to prevent this, e.g. by using a lid. The low-level response above focused on collecting and weighing the 'smoke', and this was quite a common error. However, the question makes it clear that this is only 'some' of the calcium oxide. Candidates should read questions carefully.

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