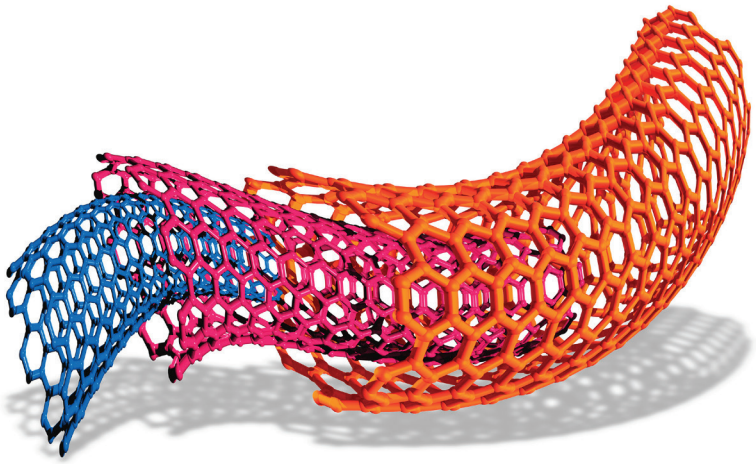
Cambridge Assessment International Education

Example Candidate Responses
Paper 3

Cambridge IGCSE®
Chemistry 0620



Version 2.0

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

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 (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

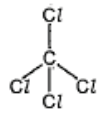
Paper 3 – Theory (Core)

Question 1

Example Candidate Response – Question 1, High	Examiner comments

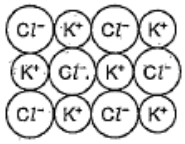
1 The structures of some substances containing chlorine are shown.

A

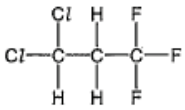


B

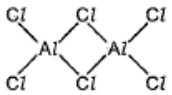
C



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

Total mark awarded = 8 out of 9

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

How the candidate could have improved the answer

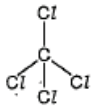
Most answers were correct. **(a) (iii)** could be regarded as a model answer, as it gives a concise and accurate definition of an element.

(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

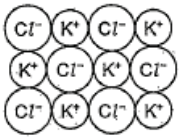
1 The structures of some substances containing chlorine are shown.

A

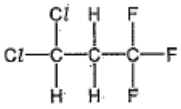


B

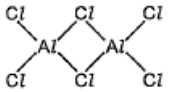
C



D



E



(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?

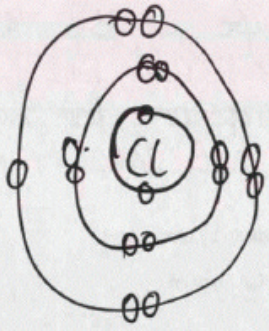
Same atomic mass but different number 5 [1]

(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.

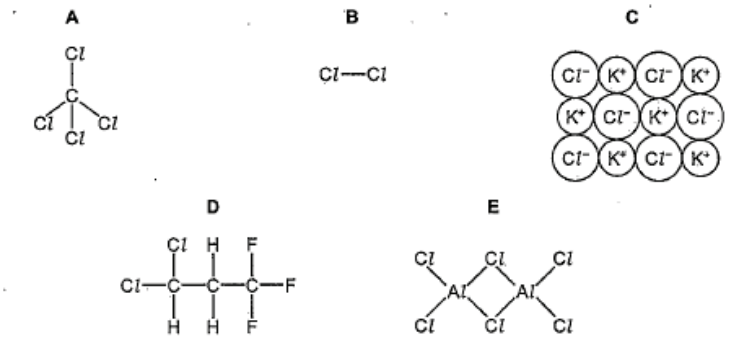
(a) (iv) was acceptable but a standard molecular formula $C_3H_3F_3Cl_2$ would have been better.

(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]

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

C [1]

(iii) Which substance is an element?

Explain your answer.

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

(iv) Determine the simplest formula for substance D.

$C_2H_3F_3$ [1]

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

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

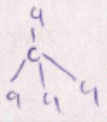
(i) How do these two isotopes differ in their atomic structure?

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

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

18 [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]

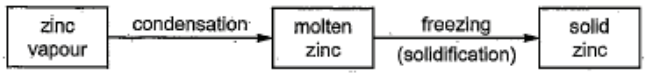
(iii) Molten aluminium oxide is electrolysed using graphite electrodes.

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~~ 4 [1]
not reactive ~~a good conductor of electri~~

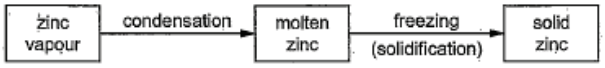
(iii) Molten aluminium oxide is electrolysed using graphite electrodes.

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.

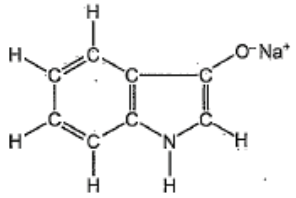
Explain your answer.

Solid because it ~~boils~~ ~~first~~ 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

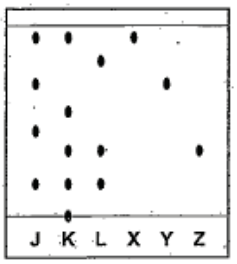
4 A reactive metal reacting with cold water produces the hydroxide not the oxide.

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.

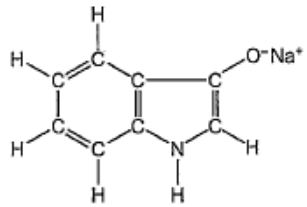
Explain your answer.

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

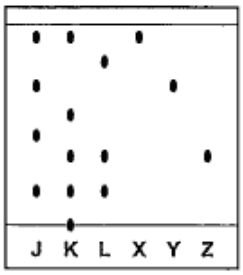
4 A reactive metal reacting with cold water produces the hydroxide not the oxide.

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.

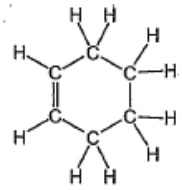
(d) (iv) Mixture K was again the commonest incorrect answer.

Question 4

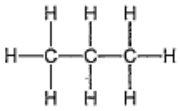
Example Candidate Response – Question 4, High	Examiner comments

4 The structures of some organic compounds are shown.

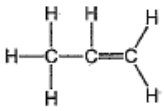
P



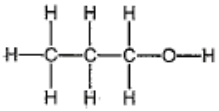
Q



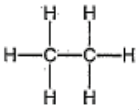
R



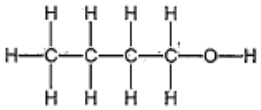
S



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

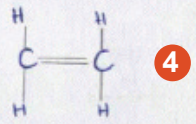
3 The only error is the suggestion of a trend in physical properties. In a homologous series there is a trend in physical properties and not a similarity. The similarity in the functional group makes the chemical properties similar.

Mark awarded for (b) = 2 out of 3

Example Candidate Response – Question 4, High	Examiner comments

(c) Ethene is an alkene.

(i) Draw the structure of ethene showing all atoms and all bonds.



4

[1]

(ii) Describe how aqueous bromine is used to show that ethene is an unsaturated compound.

Aqueous bromine is mixed with ethene and it becomes decolourised showing it is an unsaturated compound. 5

[2]

(iii) Ethene is manufactured by cracking.

State the conditions needed for cracking.

There has to be a heat supply. 6

[1]

(iv) Complete the chemical equation for the cracking of hexadecane, $C_{16}H_{34}$, to form propene and one other hydrocarbon.

$C_{16}H_{34} \rightarrow C_3H_6 + C_{13}H_{28}$ 7

[1]

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

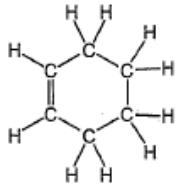
(a) (i) The answer 'the same functional group' was not accurate enough because compounds P and R also have the same functional group. The question asks about the alcohol functional group rather than the functional group present in the alkenes. The candidate would have gained the extra mark by writing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

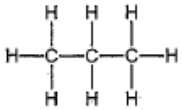
Example Candidate Response – Question 4, Low

4 The structures of some organic compounds are shown.

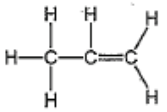
P



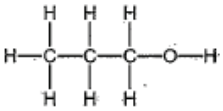
Q



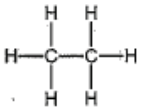
R



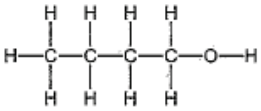
S



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]

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

P & R [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 ..mixtures.. with similar ..physical.. properties due to the same ..elements.. 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).

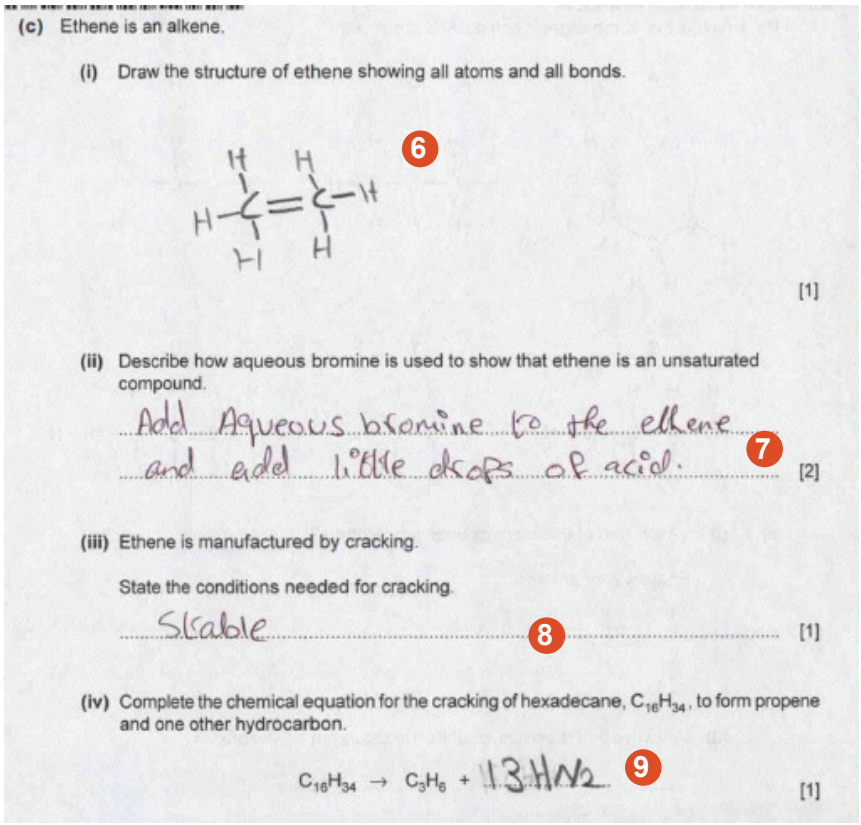
Mark awarded for (a) = 1 out of 3

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 is the lower 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 [1]

(b) The reaction is reversible.

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

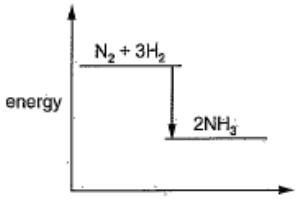
$N_2 + 3H_2$ ⇌ $2NH_3$ 2

[1]

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

Is this reaction exothermic or endothermic?

Give a reason for your answer.



endo ther endothermic because it is 3

losing heat losing energy. [1]

1 Correct.

Mark awarded for (a) = 1 out of 1

2 The sign for a reversible reaction is correct.

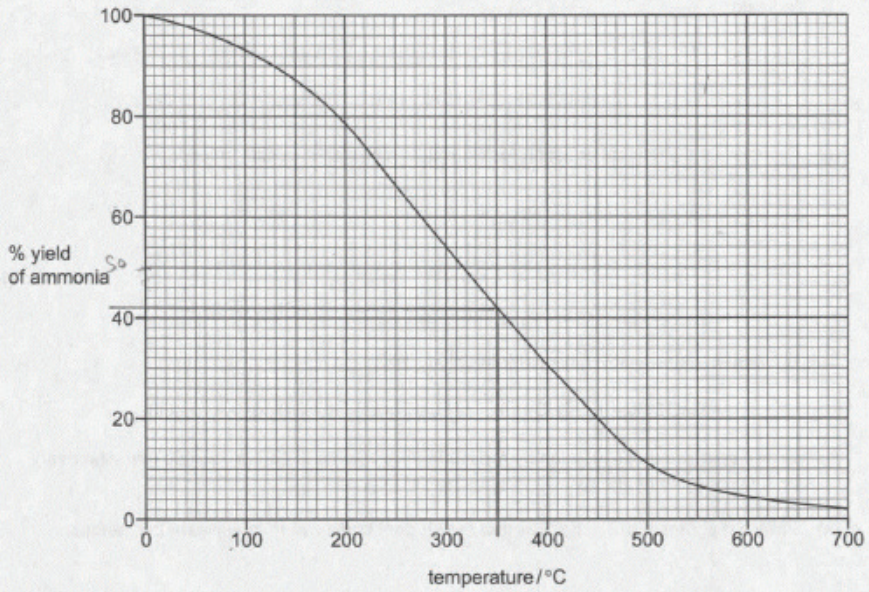
Mark awarded for (b) = 1 out of 1

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

(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 4 [1]

(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]

Examiner comments

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

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?

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.

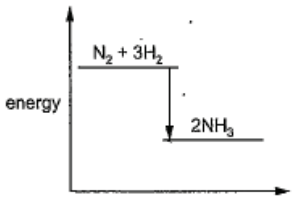
$N_2 + 3H_2$ ⇌ $2NH_3$ 2

[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]

1 Correct.

Mark awarded for (a) =
1 out of 1

2 The symbol for a reversible reaction is correct.

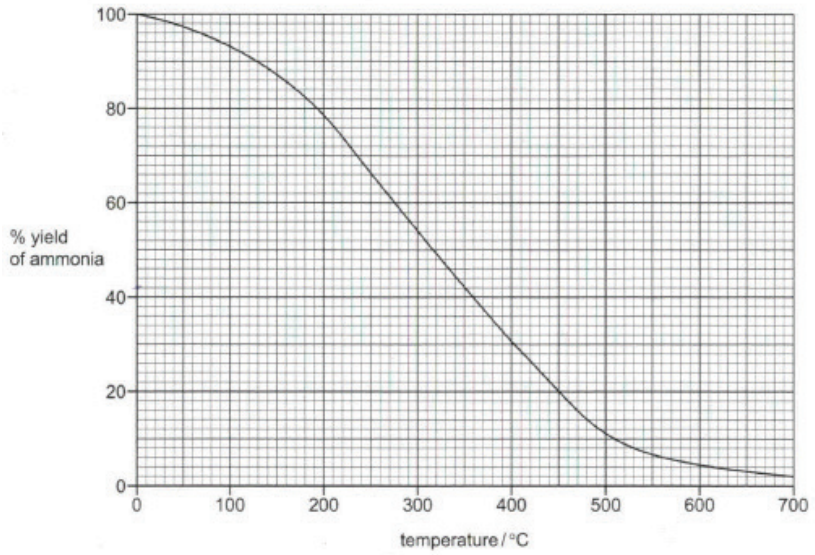
Mark awarded for (b) =
1 out of 1

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 acid 6

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 was 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 + $3Cl_2$ → 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.

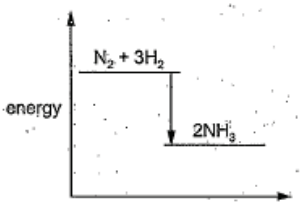
$N_2 + 3H_2$ ⇌ $2NH_3$ 2

[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.

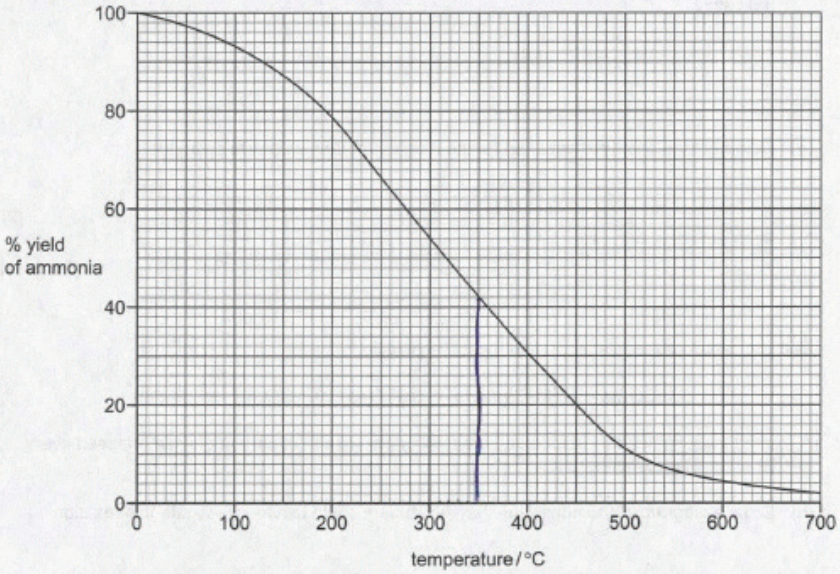
Mark awarded for (b) = 1 out of 1

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.

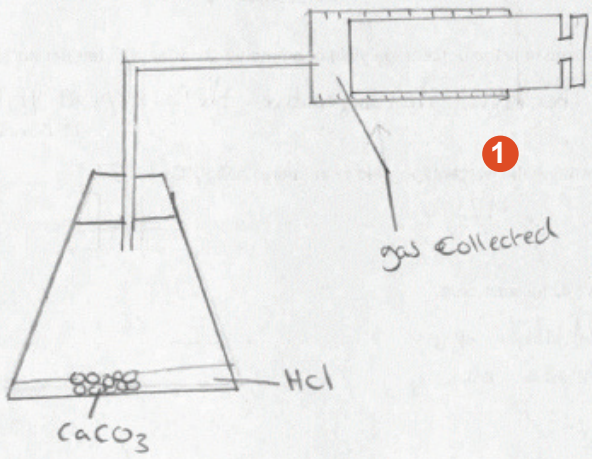
(d) (ii) The commonest error was to suggest 41%, based on a misreading of the graph.

(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.

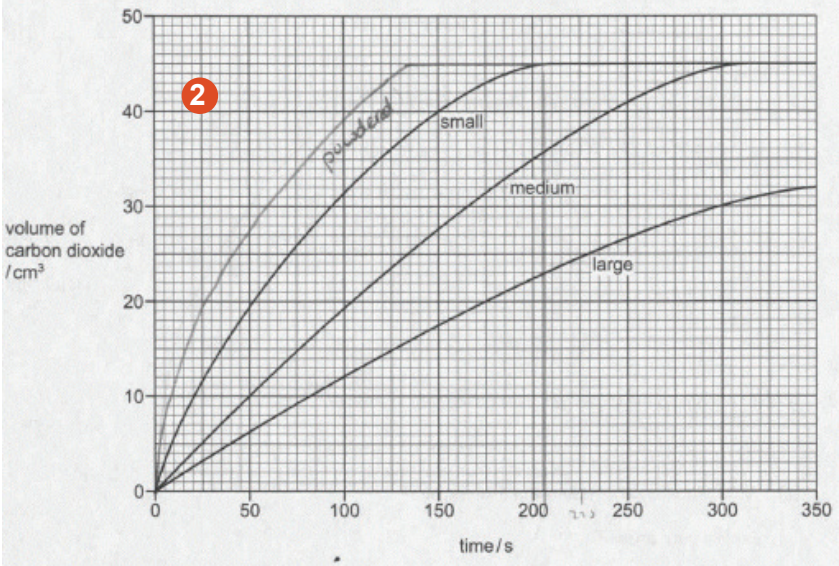
(g) The balance of the HCl was often incorrect, common errors being 2HCl or 3HCl.

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?

~~2250~~ 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

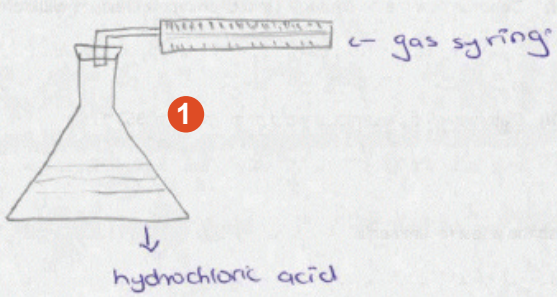
How the candidate could have improved the answer

(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.

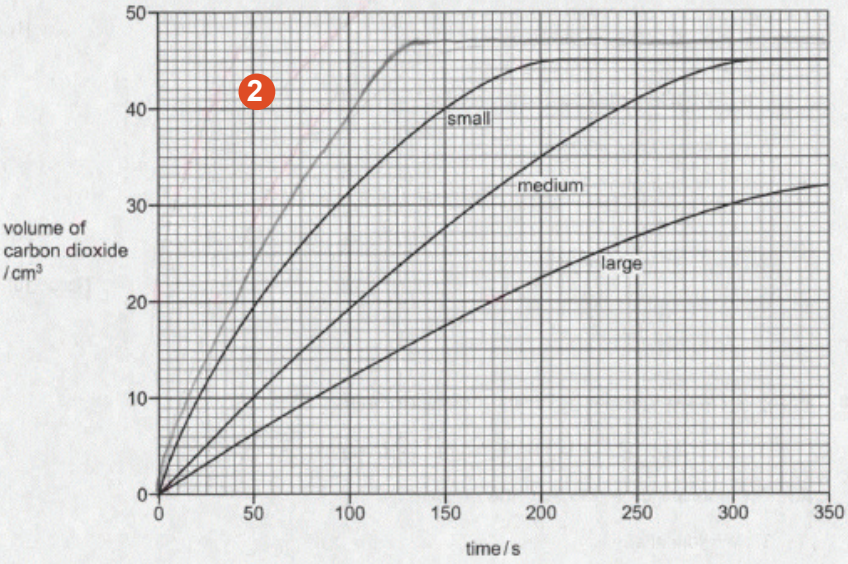
(b) (ii) The marks were given but the line could have been improved by making it more curved towards the end.

(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

(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 3

- because it becomes constant in 200s other [2]

than the others two

(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 4 [1]

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

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

as an ore 5 [1]

(ii) What type of oxide is calcium oxide?

Explain your answer.

oxygen 6

[2]

Examiner comments

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.

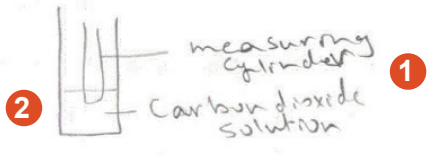
(b) (i) The answer could have been improved by stating that the small marble chips finished reacting *before* the others.

(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.

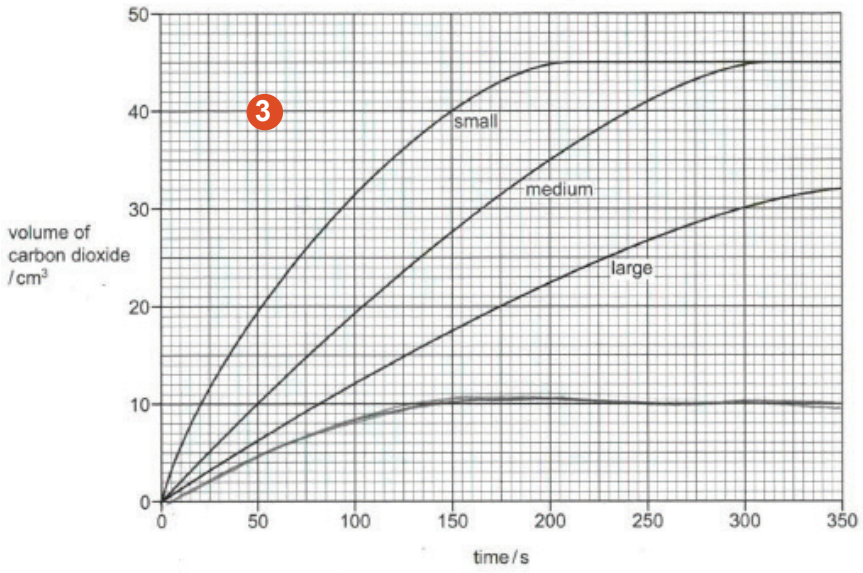
(c) (i) The mark could have been gained by referring to the uses of the various compounds named in the syllabus.

(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.  	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~~ 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.

~~then~~ ~~water~~ oxygen 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.

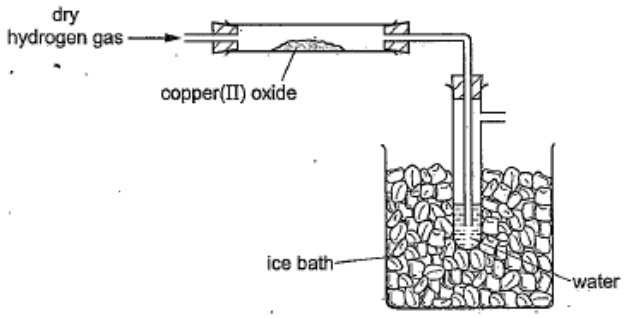
(b) (ii) Many candidates lost a mark because they either finished the line on the graph too far above the 45 cm^3 level or made the line level off after 200 seconds. Another common error was to start the line above the origin (0-0).

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

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

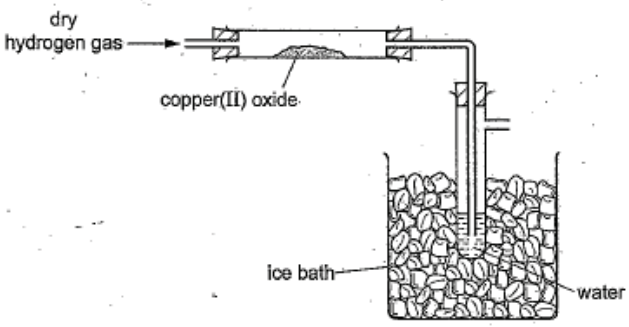
$$CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(g)$$

(a) Which substance is reduced in this reaction?

Explain your answer.

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 cant. (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]

(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.

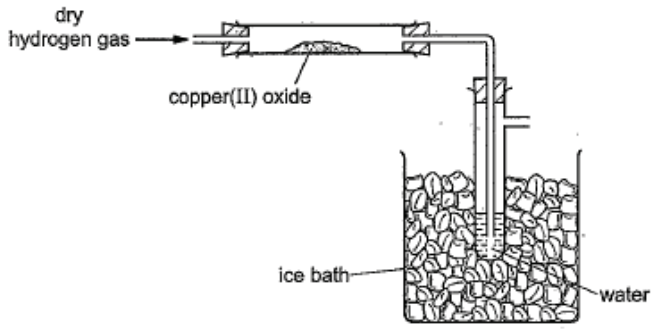
$$CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(g)$$

(a) Which substance is reduced in this reaction?

Explain your answer.

water/ 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.

Your electrical heating is more Accurate 4 [1]

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

test PH/Iscale 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.

Cambridge Assessment International Education
1 Hills Road, Cambridge, CB1 2EU, United Kingdom
t: +44 1223 553554 f: +44 1223 553558
e: info@cambridgeinternational.org www.cambridgeinternational.org