Cambridge Assessment International Education

Example Candidate Responses – Paper 4

Cambridge IGCSE™ / IGCSE (9-1)

Chemistry 0620 / 0971

For examination from 2021

Cambridge Pathway

Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge IGCSE™ / IGCSE (9-1) Chemistry 0620 / 0971, 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 from the June 2021 series to exemplify a range of answers.

For each question, the response is annotated with a clear explanation of where and why marks were awarded or omitted. This 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 could do to improve their answers. There is also a list of common mistakes candidates made in their answers for each question.

This document provides illustrative examples of candidate work with examiner commentary. These help teachers to assess the standard required to achieve marks beyond the guidance of the mark scheme. Therefore, in some circumstances, such as where exact answers are required, there will not be much comment

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

0620 June 2021 Question Paper 42

0620 June 2021 Mark Scheme 42

Past exam resources and other teaching and learning resources are available on the School Support Hub:

www.cambridgeinternational.org/support

How to use this booklet

This booklet goes through the paper one question at a time, showing you the high-, middle- and low-level response for each question. The candidate answers are set in a table. In the left-hand column are the candidate answers, and in the right-hand column are the examiner comments.

Example Candidate Response – low, continued	Examiner comments
(c) Aqueous silver nitrate is a colourless solution containing $Ag^+(aq)$ ions. **(i)** Describe what is seen when aqueous silver nitrate is added to aqueous sodium iodide, NaI(aq). colour change to white 5 [1] **(ii)** Write the ionic equation for the reaction between aqueous silver nitrate and aqueous sodium iodide. Include state symbols. $I^+ \quad I_{(aq)} + Ag^+_{(aq)} \rightarrow AgI_{(aq)}$ 6 [3] **(d)** In the positive test for aqueous nitrate ions, aqueous sodium hydroxide (NaOH) and one other substance are warmed with the nitrate ions. Name this other substance and the gas formed. name of substance ~~water~~ water 7 name of gas steam [2]	5 Here, 'white' alone, even if correct, is not awarded credit. Mark for (c)(i) = 0 out of 1 6 The candidate makes a good attempt at an ionic equation, the only mistake being to give the product an aqueous state, (aq), rather than the correct solid state, (s). Mark for (c)(ii) = 2 out of 3 7 The test for nitrate ions in **(d)** eludes this candidate and the responses given gained no credit.

Answers are 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. These explain where and why marks were awarded. This helps you to interpret the standard of Cambridge exams so you can help your learners to refine their exam technique.

How the candidate could have improved their answer

(c)(i) Required a description. Candidates should be informed that descriptions of observations often need two words. In this case, the first word is a colour (or colourless), and the second word is the state (solid, liquid, gas, solution, precipitate etc).

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

Common mistakes candidates made in this question

- **(c)(i)** Candidates' descriptions often did not include both a colour (or colourless) and a state (solid, liquid, gas, solution, precipitate, etc).
- **(c)(ii)** Candidates should be aware that any precipitation reaction involves (aq) + (aq) → (s) as state symbols.

Often candidates were not awarded marks because they misread or misinterpreted the questions.

Lists the common mistakes candidates made in answering each question. This will help your learners to avoid these mistakes and give them the best chance of achieving the available marks.

Question 1

Example Candidate Response – high

1 The symbols of the elements of Period 3 of the Periodic Table are shown.

Na	Mg	Al	Si	P	S	Cl	Ar

Answer the following questions about these elements.
Each element may be used once, more than once or not at all.

Write the symbol of an element which:

(a) is malleable
Na ..... [1]

(b) has only two electrons in its outermost shell
Mg ..... [1]

(c) forms an oxide which leads to acid rain
S ..... [1]

(d) forms an ion with a 2– charge
S ..... [1]

(e) is extracted from an ore called bauxite
Al ..... [1]

(f) does **not** form an oxide
Ar ..... [1]

(g) forms an oxide with a macromolecular structure
Si ..... [1]

(h) forms an amphoteric oxide
Al ..... [1]

(i) exists as diatomic molecules
Cl ..... [1]

(j) forms a binary compound with hydrogen that is a strong acid.
Cl ..... [1]

[Total: 10]

Examiner comments

1 This is a typical response from a high-level candidate. All answers are correct.

Mark for (a) = 1 out of 1
Mark for (b) = 1 out of 1
Mark for (c) = 1 out of 1
Mark for (d) = 1 out of 1
Mark for (e) = 1 out of 1
Mark for (f) = 1 out of 1
Mark for (g) = 1 out of 1
Mark for (h) = 1 out of 1
Mark for (i) = 1 out of 1
Mark for (j) = 1 out of 1

Total mark awarded = 10 out of 10

How the candidate could have improved their answer

Sub-questions in this introduction question were designed to have increasing difficulty. High-level candidates would be expected to gain maximum or near maximum marks.

Example Candidate Response – middle

1 The symbols of the elements of Period 3 of the Periodic Table are shown.

Na	Mg	Al	Si	P	S	Cl	Ar

Answer the following questions about these elements.
Each element may be used once, more than once or not at all.

Write the symbol of an element which:

(a) is malleable

Na [1]

(b) has only two electrons in its outermost shell

Mg [1]

(c) forms an oxide which leads to acid rain

S [1]

(d) forms an ion with a 2– charge

Si [1]

(e) is extracted from an ore called bauxite

Al [1]

(f) does **not** form an oxide

Ar [1]

(g) forms an oxide with a macromolecular structure

P [1]

(h) forms an amphoteric oxide

Na [1]

(i) exists as diatomic molecules

[1]

(j) forms a binary compound with hydrogen that is a strong acid.

Cl [1]

[Total: 10]

Examiner comments

1 This is a typical response from a middle-level candidate. The first three sub-questions are correctly answered. There is confusion over Si for S in **(d)**; assuming P forms a macromolecular structure in **(g)**, and that Na is amphoteric in **(h)**, which shows a more limited knowledge of the elements in Period 3. The candidate has not responded to **(i)**.

Mark for (a) = 1 out of 1
Mark for (b) = 1 out of 1
Mark for (c) = 1 out of 1
Mark for (d) = 0 out of 1
Mark for (e) = 1 out of 1
Mark for (f) = 1 out of 1
Mark for (g) = 0 out of 1
Mark for (h) = 0 out of 1
Mark for (i) = 0 out of 1
Mark for (j) = 1 out of 1

Total mark awarded = 6 out of 10

How the candidate could have improved their answer

Candidates should be encouraged not to leave blanks, as in **(i)**, as the answer to this sub-question must be one of the eight elements given in the table at the start of Question 1.

Example Candidate Response – low

1 The symbols of the elements of Period 3 of the Periodic Table are shown.

2,8,1 2,8,2 2,8,3 2,8,4 2,8,5 2,8,6 2,8,7 2,8,8

Na	Mg	Al	Si	P	S	Cl	Ar

Answer the following questions about these elements.
Each element may be used once, more than once or not at all.

Write the symbol of an element which:

(a) is malleable

Al ..... [1]

(b) has only two electrons in its outermost shell

Mg ..... [1]

(c) forms an oxide which leads to acid rain

Ar ..... [1]

(d) forms an ion with a 2– charge

~~Mg~~ S ..... [1]

(e) is extracted from an ore called bauxite

Na ..... [1]

(f) does **not** form an oxide

P ..... [1]

(g) forms an oxide with a macromolecular structure

Cl ..... [1]

(h) forms an amphoteric oxide

Si ..... [1]

(i) exists as diatomic molecules

Al ..... [1]

(j) forms a binary compound with hydrogen that is a strong acid.

P , Mg ..... [1]

[Total: 10]

Examiner comments

1 This is a typical response from a low-level candidate. The candidate correctly answers **(a)**, **(b)** and **(d)** only. It should be noted that the candidate provides two answers to **(j)**. In this example, both answers are incorrect. However, the candidate would not be awarded the mark even if one of the answers is correct as an incorrect response has been provided.

Mark for (a) = 1 out of 1
Mark for (b) = 1 out of 1
Mark for (c) = 0 out of 1
Mark for (d) = 1 out of 1
Mark for (e) = 0 out of 1
Mark for (f) = 0 out of 1
Mark for (g) = 0 out of 1
Mark for (h) = 0 out of 1
Mark for (i) = 0 out of 1
Mark for (j) = 1 out of 1

Total mark awarded = 4 out of 10

How the candidate could have improved their answer

Candidates need to be advised that if one answer is required, only one answer should be given. Incorrect responses are likely to contradict any correct responses and result in 0 marks being awarded.

Common mistakes candidates made in this question

The two types of common mistake were leaving parts of the question blank (when the answer had to be one of the eight elements given at the beginning of the question) or providing two answers when only one was asked for.

Question 2

Example Candidate Response – high

2 Silver has an atomic number of 47.

(a) Naturally occurring atoms of silver are ^{107}Ag and ^{109}Ag.

(i) State the name given to atoms of the same element with different nucleon numbers.

Isotopes [1]

(ii) Complete the table to show the number of protons, neutrons and electrons in each atom and ion of silver shown.

	$^{107}_{47}Ag$	$^{109}_{47}Ag^{+}$
protons	47	47
neutrons	60	62
electrons	47	46

[3]

(iii) Complete this definition of relative atomic mass. 1

Relative atomic mass is the atomic mass of naturally occurring atoms of an element on a scale where the carbon atom has a mass of exactly 12 units. [3]

(iv) A sample of silver has a relative atomic mass of 108.0.

Deduce the percentage of ^{107}Ag present in this sample of silver.

50% [1]

(b) Silver nitrate is a salt of silver made by reacting silver oxide with an acid.

Write the formula of the acid which reacts with silver oxide to form silver nitrate.

HNO_3 [1]

Examiner comments

1 This candidate is unaware that the missing first word is 'average'. 'Atomic' was a typical incorrect response. The atom upon which the scale is based is a 'carbon-12' atom. 'Carbon' is too vague as this could have been a carbon-14 atom. However, like most high-level candidates, this candidate is aware that the mass of this carbon atom is '12' units.

Mark for (a)(i) = 1 out of 1

Mark for (a)(ii) = 3 out of 3
Mark for (a)(iii) = 1 out of 3
Mark for (a)(iv) = 1 out of 1
Mark for (b) = 1 out of 1

Example Candidate Response – high, continued

(c) Aqueous silver nitrate is a colourless solution containing $Ag^+(aq)$ ions.

(i) Describe what is seen when aqueous silver nitrate is added to aqueous sodium iodide, NaI(aq).

A pale yellow precipitate or solid produced [1]

(ii) Write the ionic equation for the reaction between aqueous silver nitrate and aqueous sodium iodide.
Include state symbols.

$Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$ [3]

(d) In the positive test for aqueous nitrate ions, aqueous sodium hydroxide and one other substance are warmed with the nitrate ions.

Name this other substance and the gas formed.

name of substance Aluminium

name of gas Ammonia

[2]

(e) When silver nitrate is exposed to sunlight, silver is formed.

Name the type of reaction which needs light to make it happen.

~~Photochemical reaction~~ photochemical reaction [1]

(f) Members of one homologous series only react with chlorine in the presence of sunlight.

(i) Name a member of this homologous series.

Ethane [1]

(ii) Name **two** products that form when the compound in **(i)** reacts with chlorine.

1 1-chloroethane

2 Hydrogen Chloride

[2]

[Total: 19]

Butan-1-ol

Examiner comments

Mark for (c)(i) = 1 out of 1
Mark for (c)(ii) = 3 out of 3
Mark for (d) = 2 out of 2
Mark for (e) = 1 out of 1
Mark for (f)(i) = 1 out of 1
Mark for (f)(ii) = 1 out of 2

Total mark awarded = 16 out of 19

How the candidate could have improved their answer

High-level candidates performed well on this question with only **(a)(iii)** proving difficult.

Example Candidate Response – middle

2 Silver has an atomic number of 47.

(a) Naturally occurring atoms of silver are ^{107}Ag and ^{109}Ag.

(i) State the name given to atoms of the same element with different nucleon numbers.

isotope [1]

(ii) Complete the table to show the number of protons, neutrons and electrons in each atom and ion of silver shown.

	$^{107}_{47}Ag$	$^{109}_{47}Ag^{+}$
protons	47.	47.
neutrons	60	~~62~~
electrons	47.	46.

[3]

(iii) Complete this definition of relative atomic mass. 1

Relative atomic mass is the relative mass of naturally occurring atoms of an element on a scale where the C^{12} atom has a mass of exactly 6.02×10^{23} units.

[3]

(iv) A sample of silver has a relative atomic mass of 108.0. 2

Deduce the percentage of ^{107}Ag present in this sample of silver.

99.07% [1]

(b) Silver nitrate is a salt of silver made by reacting silver oxide with an acid.

Write the formula of the acid which reacts with silver oxide to form silver nitrate.

$Ag_2O + 2HNO_3 \rightarrow 2AgNO_3 + H_2O$ [1]

3

Examiner comments

Mark for (a)(i) = 1 out of 1
Mark for (a)(ii) = 3 out of 3

1 The candidate correctly identifies the atom upon which the scale is based, but their other answers are incorrect.
Mark for (a)(iii) = 1 out of 3

2 The percentage is incorrect.
Mark for (a)(iv) = 0 out of 1

3 Instead of simply giving the formula for the acid which produces silver nitrate from silver oxide, the candidate writes an equation. Fortunately, the formula HNO_3 is seen as a reactant so credit is given.
Mark for (b) = 1 out of 1

Example Candidate Response – middle, continued

(c) Aqueous silver nitrate is a colourless solution containing $Ag^+(aq)$ ions.

(i) Describe what is seen when aqueous silver nitrate is added to aqueous sodium iodide, NaI(aq).

white ~~precipitate~~ ~~precipitation~~ precipitation [1]

(ii) Write the ionic equation for the reaction between aqueous silver nitrate and aqueous sodium iodide.
Include state symbols.

~~$AgNO_3(aq) + NaI(aq) \rightarrow NaNO_3(s) + AgI(aq)$~~ [3]

$NO_3^-(aq) + Na^+(aq) \rightarrow NaNO_3(s)$

(d) In the positive test for aqueous nitrate ions, aqueous sodium hydroxide and one other substance are warmed with the nitrate ions.

$NaOH + HNO_3 \rightarrow$ Na.

Name this other substance and the gas formed.

name of substance ~~nitrate~~ acid

name of gas ~~nitrate~~ hydrogen [2]

$NaOH + AgNO_3 \rightarrow NaNO_3 +$ AgO_2

(e) When silver nitrate is exposed to sunlight, silver is formed.

Name the type of reaction which needs light to make it happen.

~~photochemical~~ photosynthesis [1]

(f) Members of one homologous series only react with chlorine in the presence of sunlight.

(i) Name a member of this homologous series.

~~methane~~ ~~glucose~~ methane [1]

(ii) Name **two** products that form when the compound in **(i)** reacts with chlorine.

1 hydrochloride

2 ~~chlorine methane~~ Chlorine methane

[2]

[Total: 19]

Examiner comments

4 The precipitation reactions of halides are not known by the candidate in **(c)**. The candidate opts for 'white' instead of 'yellow' as the colour of the precipitate in **(c)(i)**.
Mark for (c)(i) = 0 out of 1

Mark for (c)(ii) = 1 out of 3

5 The candidate does not recall the test for notrate ions and the responses given gain no credit.
Mark for (d) = 0 out of 2

6 The candidate unfortunately crosses out the correct answer to **(e)** and replaces it with an incorrect one.
Mark for (e) = 0 out of 1

7 The candidate knows that the homologous series are alkanes and correctly gives the name of an alkane in **(f)(i)**. The names given for the two products are close, but not accurate enough for the marks to be awarded. 'hydrochloride' is not the same as the expected 'hydrogen chloride' and 'chlorine methane' is not the same as 'chloromethane'.
Mark for (f)(i) = 1 out of 1

Mark for (f)(ii) = 0 out of 2

Total mark awarded =
8 out of 19

How the candidate could have improved their answer

- **(a)(iv)** Like many middle-level candidates, the idea that if the relative atomic mass was 108.0 and there were two isotopes, one weighing 107 and the other 109 units then each must be present in 50% proportions, was not understood.
- **(b)** The candidate should have just given the formula for the acid which produces silver nitrate from silver oxide.
- **(c)** Candidates should be aware that any precipitation reaction involves (aq) + (aq) → (s) as state symbols.

Example Candidate Response – low

2 Silver has an atomic number of 47.

(a) Naturally occurring atoms of silver are ^{107}Ag and ^{109}Ag.

(i) State the name given to atoms of the same element with different nucleon numbers.

isotop isomer 1 ..... [1]

(ii) Complete the table to show the number of protons, neutrons and electrons in each atom and ion of silver shown.

	$^{107}_{47}Ag$	$^{109}_{47}Ag^{+}$
protons	47	47
neutrons	60	62
electrons	47 ~~47~~	47 ~~46~~

2

[3]

(iii) Complete this definition of relative atomic mass.

Relative atomic mass is the .....atomic..... mass of naturally occurring atoms of an element on a scale where the .....carbon..... atom has a mass of exactly .....$\frac{1}{12}$..... units.

[3]

(iv) A sample of silver has a relative atomic mass of 108.0.

Deduce the percentage of ^{107}Ag present in this sample of silver.

101% 3 ..... [1]

(b) Silver nitrate is a salt of silver made by reacting silver oxide with an acid.

Write the formula of the acid which reacts with silver oxide to form silver nitrate.

....$Zn(NO_3)_2$.... 4 ..... [1]

Examiner comments

1 Like many low-level candidates, this candidate writes isomers instead of isotopes for **(a)(i)**.
Mark for (a)(i) = 0 out of 1

2 The candidate, although knowing the correct numbers of protons and neutrons, does not appreciate that the number of electrons for a positive ion are one less than an atom.
Mark for (a)(ii) = 2 out of 3

Mark for (a)(iii) = 0 out of 3

3 An answer greater than 100% suggests that the idea of relative atomic mass is not known.
Mark for (a)(iv) = 0 out of 1

4 The candidate writes the formula of a salt instead of the formula of an acid.
Mark for (b) = 0 out of 1

Example Candidate Response – low, continued

(c) Aqueous silver nitrate is a colourless solution containing $Ag^+(aq)$ ions.

(i) Describe what is seen when aqueous silver nitrate is added to aqueous sodium iodide, NaI(aq).

colour change to white 5 [1]

(ii) Write the ionic equation for the reaction between aqueous silver nitrate and aqueous sodium iodide.
Include state symbols.

$I^+ I(aq) + Ag^+(aq) \rightarrow AgI(aq)$ 6 [3]

(d) In the positive test for aqueous nitrate ions, aqueous sodium hydroxide (NaOH) and one other substance are warmed with the nitrate ions.

Name this other substance and the gas formed.

name of substance water ~~water~~ 7

name of gas steam

[2]

(e) When silver nitrate is exposed to sunlight, silver is formed.

Name the type of reaction which needs light to make it happen.

addition [1]

(f) Members of one homologous series only react with chlorine in the presence of sunlight. 8

(i) Name a member of this homologous series.

hydroxide acid [1]

(ii) Name **two** products that form when the compound in **(i)** reacts with chlorine.

1 water

2 carbon dioxide

[2]

[Total: 19]

Examiner comments

5 Here, 'white' alone, even if correct, is not awarded credit.
Mark for (c)(i) = 0 out of 1

6 The candidate makes a good attempt at an ionic equation, the only mistake being to give the product an aqueous state, (aq), rather than the correct solid state, (s).
Mark for (c)(ii) = 2 out of 3

7 The candidate forgets the test for nitrate ions in **(d)** and the responses given gain no credit.
Mark for (d) = 0 out of 2

8 In **(e)** and **(f)**, the candidate does not know the concepts of organic chemistry needed. 'Addition' should have been 'photochemical'. The fictitious 'hydroxide acid' should have been a named alkane, such as, 'methane' and the two products should have been 'hydrogen chloride' and 'chloromethane', instead of the products of combustion.
Mark for (e) = 0 out of 1

Mark for (f)(i) = 0 out of 1
Mark for (f)(ii) = 0 out of 2

Total mark awarded = 4 out of 19

How the candidate could have improved their answer

(c)(i) This response required a description. Candidates should be informed that descriptions of observations often need two words. In this case, the first word is a colour (or colourless), and the second word is the state (solid, liquid, gas, solution, precipitate, etc).

Common mistakes candidates made in this question

- **(c)(i)** Candidates' descriptions often did not include both a colour (or colourless) and a state (solid, liquid, gas, solution, precipitate, etc).
- **(c)(ii)** Candidates should be aware that any precipitation reaction involves (aq) + (aq) → (s) as state symbols.

Question 3

Example Candidate Response – high

3 Sodium hydrogencarbonate is found in baking powder.

When sodium hydrogencarbonate is heated it forms three products.

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

(a) Name the type of reaction that takes place when sodium hydrogencarbonate reacts in this way.

Thermal decomposition ..... [1]

(b) Calculate the volume of carbon dioxide formed at room temperature and pressure when 12.6 g of $NaHCO_3$ is heated using the following steps:

- determine the mass of one mole of $NaHCO_3$

RMM: 23+1+12+48
= 84
1×84 = 84

84 ..... g

- calculate the number of moles of $NaHCO_3$ used

$\frac{12.6}{84} = 0.15$

0.15 ..... moles

- determine the number of moles of carbon dioxide formed

0.15 ÷ 2 = 0.075

0.075 ..... moles

- calculate the volume of carbon dioxide formed at room temperature and pressure.

0.075 × 24 = 1.8

1.8 ..... dm^3 [4]

(c) Limewater is aqueous calcium hydroxide. Carbon dioxide turns limewater milky because a white precipitate forms.

Write the formula of:

- calcium hydroxide $Ca(OH)_2$ 1
- the white precipitate that forms when limewater turns milky. ~~Calcium hydrogencarbonate~~ $Ca(HCO_3)_2$ [2]

[Total: 7]

Examiner comments

Mark for (a) = 1 out of 1
Mark for (b) = 4 out of 4

1 The candidate gives $Ca(HCO_3)_2$ as the formula of the precipitate seen in limewater instead of the correct $CaCO_3$.
Mark for (c) = 1 out of 2

Total mark awarded = 6 out of 7

How the candidate could have improved their answer

Most high-level candidates successfully answered this question in a similar manner with full working out seen in **(b)**.

Example Candidate Response – middle

3 Sodium hydrogencarbonate is found in baking powder.

When sodium hydrogencarbonate is heated it forms three products.

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

(a) Name the type of reaction that takes place when sodium hydrogencarbonate reacts in this way.

substance submitte condition combustation [1]

1

(b) Calculate the volume of carbon dioxide formed at room temperature and pressure when 12.6 g of $NaHCO_3$ is heated using the following steps:

- determine the mass of one mole of $NaHCO_3$

$n = \frac{m}{Mr}$ $m = 12.6g \div 2 = 6.3g$

6.3 g

- calculate the number of moles of $NaHCO_3$ used

$n = \frac{m}{Mr} = \frac{12.6g \times 10^{-3}}{23x2+1x2+12x3+16x3} = 0.105 moles$

1.05×10^{-4} 0.105 moles

- determine the number of moles of carbon dioxide formed

$\frac{n_1}{n_2} = \frac{1}{2}$

$n(CO_2) = \frac{1}{2}(n\,NaHCO_3) = 5.25 \times 10^{-5}$ moles

5.25×10^{-5} moles

- calculate the volume of carbon dioxide formed at room temperature and pressure.

2

$n = \frac{V}{Vm}$ $V = n \times Vm = 5.25 \times 10^{-5} \times 24 = 1.26 \times 10^{-3} dm^3$

1.26×10^{-3} dm^3

[4]

(c) Limewater is aqueous calcium hydroxide ($Ca(OH)_2$). Carbon dioxide turns limewater milky because a white precipitate forms.

Write the formula of:

- calcium hydroxide $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$
- the white precipitate that forms when limewater turns milky. at constat

[2]

3

[Total: 7]

Examiner comments

1 The candidate does not know about 'thermal decomposition'.
Mark for (a) = 0 out of 1

2 In **(b)**, because the candidate shows working, it is clear to see that although M1 and M2 were not scored, division of M2 by 2 to give 5.25 x 10–5 moles of CO_2 means M3 can be awarded, and subsequent multiplication of M3 by 24 results in M4 being awarded for the volume of CO_2 produced.
Mark for (b) = 2 out of 4

3 It appears that **(c)** is misunderstood, as the candidate gives an equation for the reaction and can only be awarded the mark for $Ca(OH)_2$ and not for $CaCO_3$.
Mark for (c) = 1 out of 2

Total mark awarded = 3 out of 7

How the candidate could have improved their answer

Careful reading of the question and rereading the answer may have helped this candidate answer the actual question asked in **(c)**.

Example Candidate Response – low

3 Sodium hydrogencarbonate is found in baking powder.

When sodium hydrogencarbonate is heated it forms three products.

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

(a) Name the type of reaction that takes place when sodium hydrogencarbonate reacts in this way.

Neutralisation ..... [1]

(b) Calculate the volume of carbon dioxide formed at room temperature and pressure when 12.6 g of $NaHCO_3$ is heated using the following steps:

- determine the mass of one mole of $NaHCO_3$

$n = VC$

$= 12.6 \times [23 + 1 + (16 \times 3)]$

$= 806.4 \quad = 62$

62 / ~~806.4~~ ..... g

- calculate the number of moles of $NaHCO_3$ used

$m = M \times Mr$ $\quad = 62 \times 12.6$

~~$= 806.4 \times 12.6$~~ $\quad = 806.4$

~~$= 806.4 \times 12.6$~~

806.4 ..... moles

- determine the number of moles of carbon dioxide formed

CO_2

$12 + 16 \times 2 = 44$

44 ..... moles

- calculate the volume of carbon dioxide formed at room temperature and pressure.

18.3 ..... dm^3

[4]

(c) Limewater is aqueous calcium hydroxide. Carbon dioxide turns limewater milky because a white precipitate forms.

Write the formula of:

- calcium hydroxide ..... $CaO_2 + H_2O \rightarrow CaO_3 + H_2$ .....
- the white precipitate that forms when limewater turns milky. .....

[2]

[Total: 7]

Examiner comments

1 The candidate does not know about 'thermal decomposition'.
Mark for (a) = 0 out of 1

2 The candidate attempts to calculate a molar mass but becomes confused and starts to multiply relative atomic masses instead of adding them to give 84. The amendment of 806.4 to 62 suggests that the candidate realises the error, but (perhaps) in haste, miscalculates. The candidate realises that there is a relationship between mass and molar mass, but instead of dividing by molar mass, the candidate multiplies by molar mass. Like most low-level candidates, the idea of molar ratios is not known, and neither is multiplication by 24 to give a volume of gas.
Mark for (b) = 0 out of 4

3 Neither formulae is known.
Mark for (c) = 0 out of 2

Total mark awarded = 0 out of 7

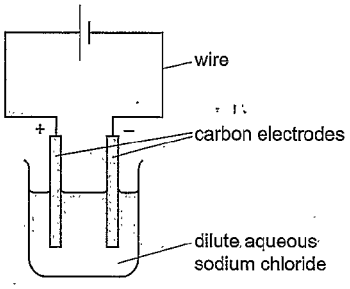
Common mistakes candidates made in this question

The most common error was misreading of the question in **(b)**. The first part asked for the mass of **one mole** of $NaHCO_3$, but many candidates determined the **number of moles** of $NaHCO_3$ here rather than in the next part.

Question 4

Example Candidate Response – high

4 A student carries out an electrolysis experiment using the apparatus shown.



1

The student uses dilute aqueous sodium chloride.

(a) State the name given to any solution which undergoes electrolysis.

Electrolyte [1]

(b) Hydroxide ions are discharged at the anode.

(i) Complete the ionic half-equation for this reaction.

4 $OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$ [2]

(ii) Explain how the ionic half-equation shows the hydroxide ions are being oxidised.

Oxidation is loss of electrons and the hydroxide ions lost 4 electrons [1]

(c) Describe what the student observes at the cathode.

Bubbles produced from the production of hydrogen [1]

(d) Write the ionic half-equation for the reaction at the cathode.

$2H^+ + 2e^- \rightarrow H_2$ [2]

(e) The student repeats the experiment using concentrated aqueous sodium chloride.

(i) Describe what the student observes at:

- the cathode Gas bubbles produced or effervescence
- the anode. Green colour gas [2]

(ii) The student added litmus to the solution after the electrolysis of concentrated aqueous sodium chloride.

State the colour seen in the solution. Give a reason for your answer.

colour of solution Blue

reason The solution is more basic because sodium hydroxide is produced. [2]

(f) Carbon electrodes are used because they are inert.

State another element that can be used instead of carbon.

Platinum [1]

[Total: 12]

Examiner comments

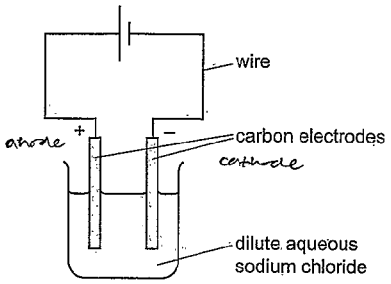
1 The candidate is awarded full credit for this question. Many high-level candidates got every sub-question correct on this question.
Mark for (a) = 1 out of 1

Mark for (b)(i) = 2 out of 2
Mark for (b)(ii) = 1 out of 1
Mark for (c) = 1 out of 1
Mark for (d) = 2 out of 2
Mark for (e)(i) = 2 out of 2
Mark for (e)(ii) = 2 out of 2
Mark for (f) = 1 out of 1

Total mark awarded = 12 out of 12

Example Candidate Response – middle

4 A student carries out an electrolysis experiment using the apparatus shown.



The student uses dilute aqueous sodium chloride.

(a) State the name given to any solution which undergoes electrolysis.

Electrolyte ..... [1]

(b) Hydroxide ions are discharged at the anode.

(i) Complete the ionic half-equation for this reaction.

2OH⁻(aq) → H_2(g) + O_2(g) + 4e⁻ [2]

(ii) Explain how the ionic half-equation shows the hydroxide ions are being oxidised.

Loss in electrons ..... [1]

(c) Describe what the student observes at the cathode. 1

~~Sodium~~ will form at the cathode ..... [1]

~~chloride ions~~ chlorine

(d) Write the ionic half-equation for the reaction at the cathode. 2

$2Cl^+_{(aq)} + 4e^- \rightarrow Cl_{2(s)}$ ..... [2]

(e) The student repeats the experiment using concentrated aqueous sodium chloride.

(i) Describe what the student observes at:

- the cathode ~~chloride ions~~ chlorine 3
- the anode. ~~sodium ions~~ sodium

[2]

(ii) The student added litmus to the solution after the electrolysis of concentrated aqueous sodium chloride.

State the colour seen in the solution. Give a reason for your answer.

colour of solution ~~Red-brown~~ Blue 4

reason solution is basic

[2]

(f) Carbon electrodes are used because they are inert.

State another element that can be used instead of carbon.

Platinum ..... [1]

[Total: 12]

Examiner comments

Mark for (a) = 1 out of 1
Mark for (b)(i) = 0 out of 2
Mark for (b)(ii) = 1 out of 1

1 The candidate states the name of the product formed, rather than a description (i.e. state; colour) of what they would observe, so cannot credit marks for their answer.
Mark for (c) = 0 out of 1

2 In **(d)**, the candidate realises that it is a positive ion which gains an electron at the cathode, so credit is awarded for indicating this, albeit, using an incorrect positive ion.
Mark for (d) = 1 out of 2

3 The candidate states the name of the product formed, rather than gives a description (i.e. state; colour) of what they would observe, so cannot credit marks for their answer.
Mark for (e)(i) = 0 out of 2

4 The candidate states the correct colour of the indicator, but although the candidate knows it is the presence of a base, they cannot state the name of the base.
Mark for (e)(ii) = 1 out of 2

Mark for (f) = 1 out of 1

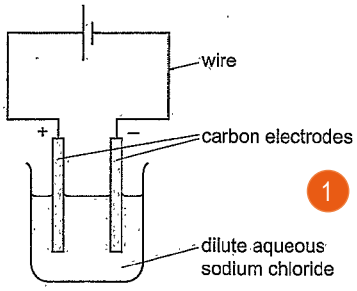
Total mark awarded = 5 out of 12

How the candidate could have improved their answer

- **(b)(i)** The candidate needed to balance the charges for the easier mark followed by balancing atoms for the harder mark.
- **(c), (e)(i)** The candidate stated the names of the products formed, but needed to give descriptions (i.e. state; colour). When asked what they would 'observe', candidates should state what they would see, not what they know (correctly or not) is being formed. An observation is not the same as drawing a conclusion.

Example Candidate Response – low

4 A student carries out an electrolysis experiment using the apparatus shown.



The student uses dilute aqueous sodium chloride.

(a) State the name given to any solution which undergoes electrolysis.

Magnesium ..... [1]

(b) Hydroxide ions are discharged at the anode.

(i) Complete the ionic half-equation for this reaction.

$Fe_4OH^-(aq) \rightarrow$ 2FeH Fe4H ..... $+ O_2(g) + 4e^-$ [2]

(ii) Explain how the ionic half-equation shows the hydroxide ions are being oxidised.

..... [1]

(c) Describe what the student observes at the cathode.

~~Sulfur~~ hydrogen ..... [1]

(d) Write the ionic half-equation for the reaction at the cathode.

$H_2SO_4 \longrightarrow SO_4 + H_2O$ ..... [2]

(e) The student repeats the experiment using concentrated aqueous sodium chloride.

(i) Describe what the student observes at:

- the cathode .....
- the anode. .....

[2]

(ii) The student added litmus to the solution after the electrolysis of concentrated aqueous sodium chloride.

State the colour seen in the solution. Give a reason for your answer.

colour of solution ..... pink to colourless .....

reason .....

[2]

(f) Carbon electrodes are used because they are inert.

State another element that can be used instead of carbon.

Iron ..... [1]

[Total: 12]

Examiner comments

1 The candidate appears unfamiliar with the electrochemistry part of the syllabus and provides responses which earn no credit.
Mark for (a) = 0 out of 1

Mark for (b)(i) = 0 out of 2
Mark for (b)(ii) = 0 out of 1
Mark for (c) = 0 out of 1
Mark for (d) = 0 out of 2
Mark for (e)(i) = 0 out of 2
Mark for (e)(ii) = 0 out of 2
Mark for (f) = 0 out of 1

Total mark awarded = 0 out of 12

Common mistakes candidates made in this question

- In ionic half-equations, such as **(b)(i)**, the key point is for candidates to balance charges.
- When describing electrode reactions in which the product is gaseous, 'effervescence' is the term which will earn credit. If the gas is coloured, such as chlorine in **(e)(i)**, then the colour of the gas should be given.

Question 5

Example Candidate Response – high

5 This question is about compounds of nitrogen.

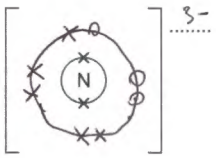
(a) Nitrogen reacts with lithium to form lithium nitride, Li_3N.

(i) Write the chemical equation for the reaction between lithium and nitrogen.

$6Li + N_2 \rightarrow 2Li_3N$ [2]

(ii) Lithium nitride is ionically bonded.

Complete the diagram to show the electronic structure of the nitride ion.
Show the charge on the nitride ion.



3-

[2]

(b) Nitrogen reacts with fluorine to form nitrogen trifluoride, NF_3.

(i) The chemical equation can be represented as shown.

$$N{\equiv}N + 3\,F{-}F \rightarrow 2\,F{-}\underset{\displaystyle F}{\underset{|}{N}}{-}F$$

Some bond energies are shown in the table.

bond	bond energy in kJ/mol
N≡N	945
F–F	160
N–F	300

Calculate the energy change for the reaction between nitrogen and fluorine, using the following steps:

- energy taken in to break bonds

$945 + 3(160) = 1425$ ..... 1425 ..... kJ

- energy released when bonds are formed

$2(300 \times 3) = 1800$ ..... 1800 ..... kJ

- energy change during the reaction.

$1425 - 1800 =$ ..... -375 ..... kJ/mol

[3]

(ii) Use your answer to **(i)** to deduce whether this reaction is endothermic or exothermic. Explain your answer.

It is exothermic because the overall energy change is negative so energy in was released. [1]

Examiner comments

Mark for (a)(i) = 2 out of 2
Mark for (a)(ii) = 2 out of 2
Mark for (b)(i) = 3 out of 3
Mark for (b)(ii) = 1 out of 1

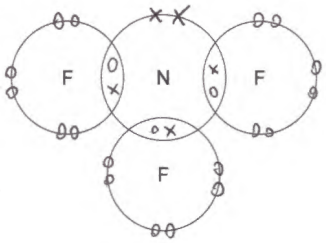
Example Candidate Response – high, continued

Examiner comments

(iii) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of NF_3.

Use dots for nitrogen electrons and crosses for fluorine electrons.

Show outer electrons only.



[3]

(c) Lithium nitride melts at 813 °C. Nitrogen trifluoride melts at –206 °C.

Explain in terms of attractive forces why lithium nitride has a much higher melting point than nitrogen trifluoride.

In your answer refer to the types of attractive forces between particles and their relative strengths.

The electrostatic forces of attraction in Lithium Nitride are much stronger than the intermolecular forces in Nitrogen trifluoride, so more energy is required to break the bonds in Lithium nitride, resulting in a higher melting point. [3]

1

(d) Ammonium nitrate, NH_4NO_3, is a compound of nitrogen.

(i) Calculate the percentage by mass of nitrogen in ammonium nitrate.

14 + 4 + 14 + 48

= 80

$\frac{28}{80} \times 100 = 35\%$

percentage by mass of nitrogen = 35% [2]

(ii) State a use of ammonium nitrate in agriculture.

Used as a fertiliser [1]

(iii) State the name of a compound that will displace ammonia from ammonium nitrate.

Sodium hydroxide [1]

(e) Ammonia is a base which forms a weakly alkaline solution when dissolved in water.

(i) Define the term *base*.

Proton acceptor [1]

(ii) Suggest the pH of aqueous ammonia.

10 [1]

[Total: 20]

Mark for (b)(iii) = 3 out of 3

1 The candidate knows that the forces of attraction between particles in lithium nitride are stronger than those in nitrogen trifluoride. The candidate gains credit for the type of particle these forces acted between using the word 'intermolecular'.
Mark for (c) = 2 out of 3

Mark for (d)(i) = 2 out of 2
Mark for (d)(ii) = 1 out of 1
Mark for(d)(iii) = 1 out of 1
Mark for (e)(i) = 1 out of 1
Mark for (e)(ii) = 1 out of 1

Total mark awarded = 19 out of 20

How the candidate could have improved their answer

(c) The candidate needed to have stated that the forces acted between 'ions' in lithium nitride: The phrase 'electrostatic attraction' was too vague.

Example Candidate Response – middle

5 This question is about compounds of nitrogen.

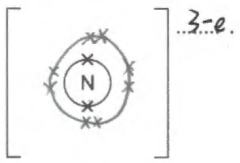
(a) Nitrogen reacts with lithium to form lithium nitride, Li_3N.

(i) Write the chemical equation for the reaction between lithium and nitrogen.

$6Li + N_2 \rightarrow 2Li_3N$ [2]

(ii) Lithium nitride is ionically bonded.

Complete the diagram to show the electronic structure of the nitride ion.
Show the charge on the nitride ion.



[2]

(b) Nitrogen reacts with fluorine to form nitrogen trifluoride, NF_3.

(i) The chemical equation can be represented as shown.

$$N{\equiv}N + 3\ F{-}F \rightarrow 2\ F{-}\underset{\displaystyle F}{\underset{|}{N}}{-}F$$

Some bond energies are shown in the table.

bond	bond energy in kJ/mol
N≡N	945
F–F	160
N–F	300

Calculate the energy change for the reaction between nitrogen and fluorine, using the following steps:

- energy taken in to break bonds

945 + 3(160)

1425 kJ

- energy released when bonds are formed

375/800 kJ

- energy change during the reaction.

375 kJ/mol [3]

(ii) Use your answer to **(i)** to deduce whether this reaction is endothermic or exothermic. Explain your answer.

~~Endotherm~~ Endothermic. Because the after energy big that before energy. [1]

Examiner comments

1 The candidate's answer to **(a)(i)** is correct and in **(a)(ii)**, the candidate is awarded full credit.
Mark for (a)(i) = 2 out of 2

Mark for (a)(ii)= 2 out of 2

2 The first two calculations are done correctly, but the candidate subtracts these values the wrong way around and ends up with a positive value of 375.
Mark for (b)(i) = 2 out of 3

3 The candidate's explanation needs to have reference to the magnitude of the first two values related to bond breaking and bond making, so no credit is awarded.
Mark for (b)(ii) = 0 out of 1

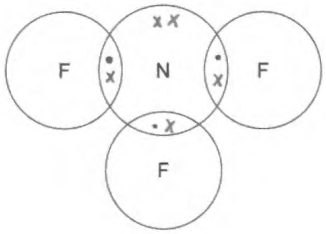
Example Candidate Response – middle, continued

Examiner comments

(iii) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of NF_3.

Use dots for nitrogen electrons and crosses for fluorine electrons.

Show outer electrons only.



4

[3]

(c) Lithium nitride melts at 813 °C. Nitrogen trifluoride melts at –206 °C.

Explain in terms of attractive forces why lithium nitride has a much higher melting point than nitrogen trifluoride.

In your answer refer to the types of attractive forces between particles and their relative strengths.

Lithium nitride the molecular attrative force ~~sma~~ stronge. they need more energy to broken down, so the melting point high. Lithimus nitrogen trifluorde the ionic attrative force small. they need samll need to broken break down. so the melting point lower. [3]

5

(d) Ammonium nitrate, NH_4NO_3, is a compound of nitrogen.

(i) Calculate the percentage by mass of nitrogen in ammonium nitrate.

NH_4NO_3

$\frac{NO_2 \text{ ~~rbt~~ } 14+(16\times2)}{14+4+14+(16\times3)}$

6

percentage by mass of nitrogen = 57.7 % [2]

(ii) State a use of ammonium nitrate in agriculture.

~~blan bante~~ land. ~~bana blanes~~ add ~~bantons~~ the acid land [1]

(iii) State the name of a compound that will displace ammonia (NH_3) from ammonium nitrate.

~~Sil~~ silver nitrate [1]

(e) Ammonia is a base which forms a weakly alkaline solution when dissolved in water.

(i) Define the term *base*.

accept the base is get proton [1]

(ii) Suggest the pH of aqueous ammonia (NH_3).

$pH > 7$ [1]

7

[Total: 20]

4 The candidate recognises that three dot and cross bonds are needed between the N atom and each F atom, and they secure a second mark for completing the octet of electrons on the N atom. The third mark is not awarded because the three pairs of non-bonding electrons on each F atom are missing.
Mark for (b)(iii) = 2 out of 3

5 The candidate gains credit for stating the relative strength of the forces. The candidate attempts to name the particles involved, but unfortunately the names of the particles are applied the wrong way around. Lithium nitride has ions. Nitrogen fluoride has molecules.
Mark for (c) = 1 out of 3

6 The candidate shows partial working, but as the final answer is incorrect, there is no evidence that the bottom line has been calculated correctly.
Mark for (d)(i) = 0 out of 2

Mark for (d)(ii) = 0 out of 1
Mark for (d)(iii) = 0 out of 1

7 The candidate knows bases are 'proton acceptors', but the answer 'ammonia has a pH above 7' does not receive credit as pH 14 is above 7 yet is the pH of a strong alkali.
Mark for (e)(i) = 1 out of 1

Mark for (e)(ii) = 0 out of 1

Total mark awarded = 10 out of 20

How the candidate could have improved their answer

- **(a)(ii)** The candidate was awarded full credit. However, although it was expected that three of the electrons in the second shell should have been dots, a full octet of electrons in the second shell was given credit. The candidate was awarded the charge mark as, although '3–' was the expected answer, it was felt the 'e' could be ignored as electrons were the species carrying the negative charges.
- **(d)(i)** If the candidate had written '= 80' on the bottom line, a mark could be awarded.
- **(e)(i)** A single integer between 7 and 11 would have secured the mark.

Example Candidate Response – low

5 This question is about compounds of nitrogen.

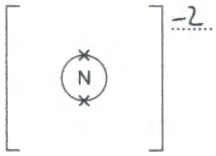
(a) Nitrogen reacts with lithium to form lithium nitride, Li_3N.

(i) Write the chemical equation for the reaction between lithium and nitrogen.

$N^{+2} + Li_2 \rightarrow Li_3N$ [2]

(ii) Lithium nitride is ionically bonded.

Complete the diagram to show the electronic structure of the nitride ion.
Show the charge on the nitride ion.



1

[2]

(b) Nitrogen reacts with fluorine to form nitrogen trifluoride, NF_3.

(i) The chemical equation can be represented as shown.

$$N{\equiv}N + 3\,F{-}F \rightarrow 2\,F{-}\underset{\displaystyle F}{\underset{|}{N}}{-}F$$

Some bond energies are shown in the table.

bond	bond energy in kJ/mol
N≡N	945
F–F	160
N–F	300

33.75
5.7
9.09

Calculate the energy change for the reaction between nitrogen and fluorine, using the following steps:

- energy taken in to break bonds

48.54 kJ

- energy released when bonds are formed

2

13.4 kJ

- energy change during the reaction.

3773730
3778930 kJ/mol
[3]

(ii) Use your answer to **(i)** to deduce whether this reaction is endothermic or exothermic. Explain your answer.

Endothermic because the result is positive

[1]

Examiner comments

1 The candidate is unfamiliar with the correct formula, N2. They do not realise that a complete octet of electrons is needed.
Mark for (a)(i) = 0 out of 2

Mark for (a)(ii) = 0 out of 2

2 The candidate does not show any working, so it is unclear where these values came from.
Mark for (b)(i) = 0 out of 3

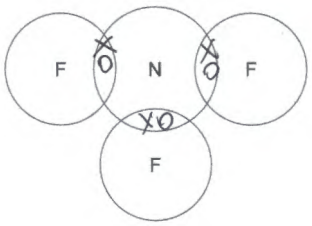
Mark for (b)(ii) = 1 out of 1

Example Candidate Response – low, continued

(iii) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of NF_3.

Use dots for nitrogen electrons and crosses for fluorine electrons.

Show outer electrons only.



3

[3]

(c) Lithium nitride melts at 813 °C. Nitrogen trifluoride melts at –206 °C.

Explain in terms of attractive forces why lithium nitride has a much higher melting point than nitrogen trifluoride.

In your answer refer to the types of attractive forces between particles and their relative strengths.

The lithimum nitride melts at 813°C, because there is metal so have high melting point and Nitrogen trifluoride have low melting because the [3]

4

(d) Ammonium nitrate, NH_4NO_3, is a compound of nitrogen.

(i) Calculate the percentage by mass of nitrogen in ammonium nitrate.

percentage by mass of nitrogen = 78% [2]

(ii) State a use of ammonium nitrate in agriculture.

Fertilizer [1]

(iii) State the name of a compound that will displace ammonia from ammonium nitrate.

Nitrogen [1]

(e) Ammonia is a base which forms a weakly alkaline solution when dissolved in water.

(i) Define the term *base*.

n [1]

(ii) Suggest the pH of aqueous ammonia.

9 [1]

[Total: 20]

Examiner comments

3 The candidate secures the first mark for showing three pairs of dot-and-cross electrons.

4 The candidate struggles as no names of particles are given. In other scripts of low-level candidates some were able to make educated guesses that ions and molecules were involved.
Mark for (c) = 0 out of 3

Mark for (d)(i) = 0 out of 2
Mark for (d)(ii) = 1 out of 1
Mark for (d)(iii) = 0 out of 1
Mark for (e)(i) = 0 out of 1
Mark for (e)(ii) = 1 out of 1

Total mark awarded = 4 out of 20

How the candidate could have improved their answer

- **(b)(iii)** Although the candidate secured the first mark for showing three pairs of dot-and-cross electrons, the candidate needed to complete the octet of electrons for the N atom for a second mark. The octets of electrons for each F atom were needed for a third mark.

Common mistakes candidates made in this question

- **(b)(ii)** The answer is dependent upon the magnitude of the values used in bond breaking/bond making processes. Candidates need to be clear that energy is needed/used/taken in to break bonds and is released/given out. when bonds are made. The ideal response would be, 'The energy **needed** to break bonds is less than the energy **released** when bonds are formed'. Candidates often used phrases which contradicted what they wished to say. Frequently seen examples were phrases such as 'The energy **needed** to break bonds is less than when bonds are formed', which unfortunately suggests that energy is also needed in bond formation.
- **(b)(iii)** The most common error was to omit non-bonding electrons in either the N atom or, more commonly, the three F atoms. It would help candidates if they represented non-bonding electrons in F as three pairs rather than six individual electrons as this is more correct and easier to count the number of electrons.
- **(c)** The ideal response would have been, 'The attraction between **ions** in Li_3N is stronger than the attraction between **molecules** in NF_3', or the reverse argument. For 'attraction between ions', many candidates wrote 'ionic bonding', which is acceptable. For 'attraction between molecules', many candidates wrote 'intermolecular forces' which is also acceptable. However, many candidates wrote, using the reverse argument, 'The intermolecular forces in NF_3 are weaker than the intermolecular forces in Li_3N' suggesting that L_3N is covalent, which contradicted statements about ionic bonding in Li_3N seen elsewhere in the response.
- **(d)(i)** Many candidates in their working did not determine a value for the relative molecular mass of NH_4NO_3, which would be acceptable as long as the final answer was correct, but this omission did not allow a working mark if the final answer was incorrect.

Question 6

Example Candidate Response – high

6 Molecules **A** and **B** can form condensation polymers.

A

B

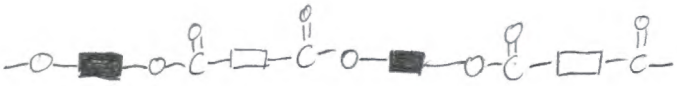
1

(a) Each molecule has two identical functional groups.

(i) Name the functional group in **B**.

Carboxylic acid ..... [1]

(ii) Draw the part of the structure of the synthetic polymer that would form when two molecules of **A** and two molecules of **B** combine. Show all of the bonds in the linkages.



[3]

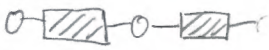
(iii) Name the other product formed when molecules of **A** and **B** undergo polymerisation.

Water ..... [1]

(b) Molecule **A** is a simple sugar unit which can be made by hydrolysis of complex carbohydrates.

(i) Draw part of the complex carbohydrate that could be hydrolysed to make molecules of **A**.

Include **one** linkage and show all of the bonds in the linkage.



[1]

(ii) State **two** sets of conditions which could be used to hydrolyse the complex carbohydrate to form **A**.

1 the ~~presence~~ use of enzymes .....

2 the presence of acid .....

[2]

(iii) Name the technique used to identify the individual sugar units made by the hydrolysis of a complex carbohydrate.

~~Chromatography~~ chromatography ..... [1]

(c) Ethanol can be made from the simple sugar glucose, $C_6H_{12}O_6$.

(i) State the name of this process.

fermentation ..... [1]

(ii) Complete the chemical equation for this reaction.

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ [2]

[Total: 12]

Examiner comments

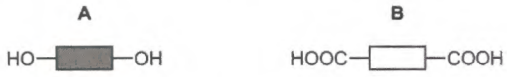
1 The candidate gains full credit for this question. This is not untypical of high-level candidates and many, like this candidate, answers every sub-question correctly.
Mark for (a)(i) = 1 out of 1

Mark for (a)(ii) = 3 out of 3
Mark for (a)(iii) = 1 out of 1
Mark for (b)(i) = 1 out of 1
Mark for (b)(ii) = 2 out of 2
Mark for (b)(iii) = 1 out of 1
Mark for (c)(i) = 1 out of 1
Mark for (c)(ii) = 2 out of 2

Total mark awarded = 12 out of 12

Example Candidate Response – middle

6 Molecules **A** and **B** can form condensation polymers.

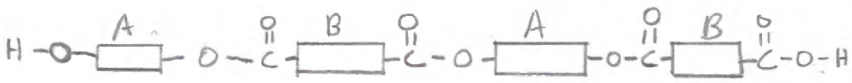


(a) Each molecule has two identical functional groups.

(i) Name the functional group in **B**.

Carboxyl [1]

(ii) Draw the part of the structure of the synthetic polymer that would form when two molecules of **A** and two molecules of **B** combine. Show all of the bonds in the linkages.



[3]

(iii) Name the other product formed when molecules of **A** and **B** undergo polymerisation.

water [1]

(b) Molecule **A** is a simple sugar unit which can be made by hydrolysis of complex carbohydrates.

(i) Draw part of the complex carbohydrate that could be hydrolysed to make molecules of **A**.

Include **one** linkage and show all of the bonds in the linkage.

[1]

(ii) State **two** sets of conditions which could be used to hydrolyse the complex carbohydrate to form **A**.

1 low pressure

2 high temperature

[2]

(iii) Name the technique used to identify the individual sugar units made by the hydrolysis of a complex carbohydrate.

fractional distillation [1]

polymerisation

(c) Ethanol can be made from the simple sugar glucose, $C_6H_{12}O_6$.

(i) State the name of this process.

~~esterification~~ ~~ester~~ fermentation [1]

(ii) Complete the chemical equation for this reaction.

$C_6H_{12}O_6 \rightarrow 3C_2H_4O_2$ [2]

[Total: 12]

1 Although carboxylic acid is the full name, 'carboxyl' is a suitable alternative
Mark for (a) = 1 out of 1

2 The candidate gains credit for drawing one ester group, and the idea of alternating ester groups along the chain also gains credit. The candidate does not show continuation bonds at each end and was not awarded the third mark.
Mark for (a)(ii) = 2 out of 3

Mark for (a)(iii) = 1 out of 1

3 The candidate knows the linkage of a complex carbohydrate in **(i)**, but the rest of the answers to **(b)** indicate a limited knowledge of this area of the syllabus.
Mark for (b)(i) = 1 out of 1

Mark for (b)(ii) = 0 out of 2
Mark for (b)(iii) = 0 out of 1

4 The candidate correctly states the name of the process in **(i)**, but the does not produce the equation needed in **(ii)**.
Mark for (c)(i) = 1 out of 1

Mark for (c)(ii) = 0 out of 2

Total mark awarded = 6 out of 12

Example Candidate Response – low

6 Molecules **A** and **B** can form condensation polymers.

A HO—▭—OH **B** HOOC—▭—COOH

(a) Each molecule has two identical functional groups.

(i) Name the functional group in **B**.

Ethanol [1]

(ii) Draw the part of the structure of the synthetic polymer that would form when two molecules of **A** and two molecules of **B** combine. Show all of the bonds in the linkages.

[3]

(iii) Name the other product formed when molecules of **A** and **B** undergo polymerisation.

water [1]

(b) Molecule **A** is a simple sugar unit which can be made by hydrolysis of complex carbohydrates.

(i) Draw part of the complex carbohydrate that could be hydrolysed to make molecules of **A**.

Include **one** linkage and show all of the bonds in the linkage.

[1]

(ii) State **two** sets of conditions which could be used to hydrolyse the complex carbohydrate to form **A**.

1 ~~Ato oxygen~~ ~~400°C~~ 300°C

2 ~~at 37°C~~ 70 atm

[2]

(iii) Name the technique used to identify the individual sugar units made by the hydrolysis of a complex carbohydrate.

PH indicator [1]

(c) Ethanol can be made from the simple sugar glucose, $C_6H_{12}O_6$.

(i) State the name of this process.

$C_nH_{2n+1}OH$

Fermentation [1]

(ii) Complete the chemical equation for this reaction.

$C_6H_{12}O_6 \rightarrow (H_2O + CH_3COOCH$ [2]

[Total: 12]

Examiner comments

1 The candidate's answer to **(i)** is incorrect, and they did not attempt to show all the bonds in the linkages in **(ii)**, so no credit could be awarded. The candidate's answer to **(iii)** is correct.
Mark for (a) = 0 out of 1

Mark for (a)(ii) = 0 out of 3
Mark for (a)(iii) = 1 out of 1

2 The candidate does not draw a linkage in **(i)**, and knowledge of this part of the syllabus is absent in parts **(ii)** and **(iii)**.
Mark for (b)(i) = 0 out of 1

Mark for (b)(ii) = 0 out of 2
Mark for (b)(iii) = 0 out of 1

3 The name of the process is correct, but the equation in **(ii)** is incorrect.
Mark for (c)(i) = 1 out of 1

Mark for (c)(ii) = 0 out of 2

Total mark awarded = 2 out of 12

Common mistakes candidates made in this question

When drawing part of a polymer chain in **(a)(ii)**, many candidates omitted to show continuation bonds.

Cambridge Assessment International Education
The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA, United Kingdom
t: +44 1223 553554
e: info@cambridgeinternational.org www.cambridgeinternational.org