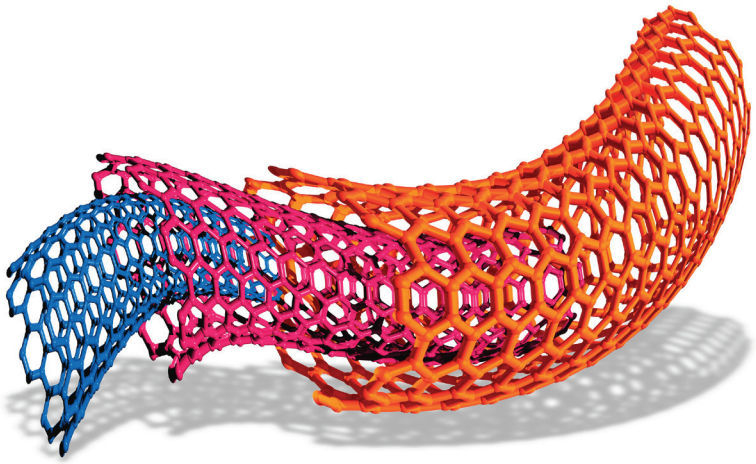
Cambridge Assessment International Education

Example Candidate Responses
Paper 4

Cambridge IGCSE®
Chemistry 0620

For examination from 2016



Version 2.0

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Contents

Introduction

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

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

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

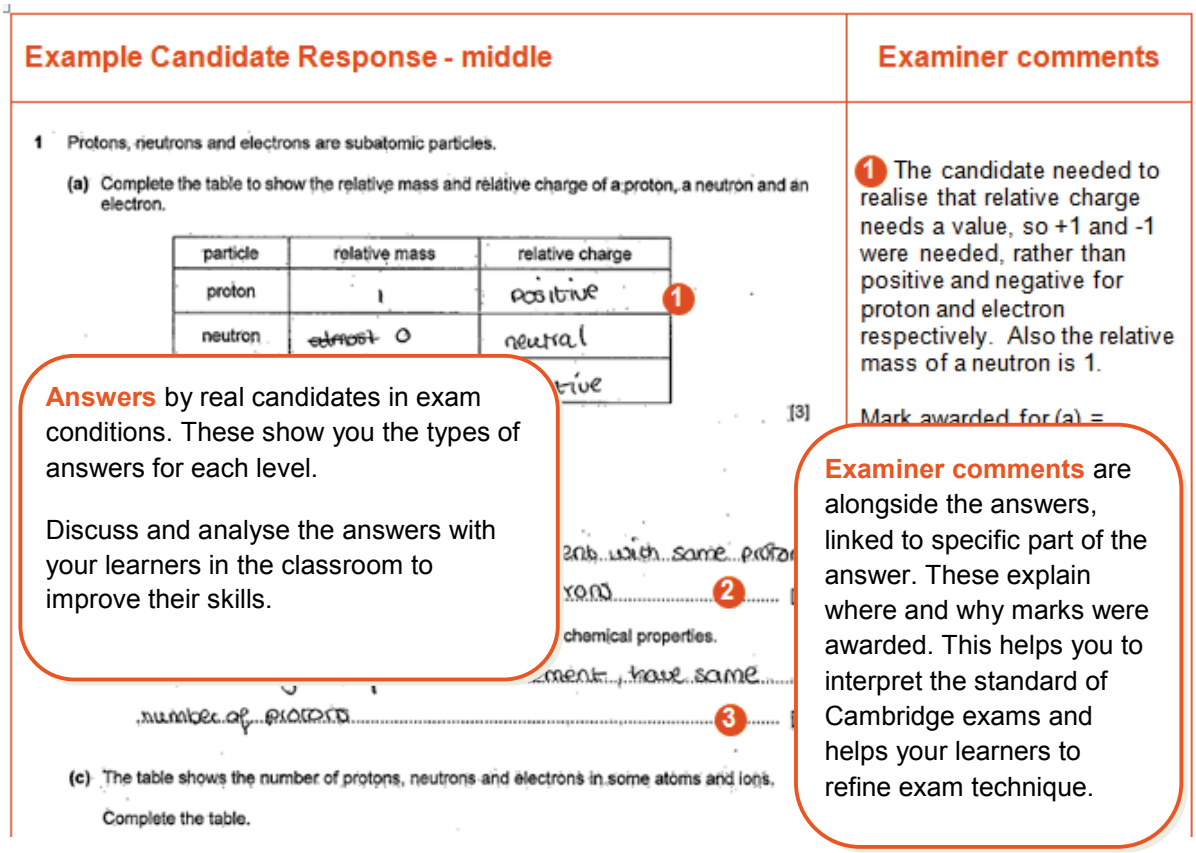
This document provides illustrative examples of candidate work. These help teachers to assess the standard required to achieve marks, beyond the guidance of the mark scheme. Some question types where the answer is clear from the mark scheme, such as short answers and multiple choice, have therefore been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

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

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

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

How to use this booklet



Example Candidate Response - middle

Examiner comments

1 Protons, neutrons and electrons are subatomic particles.

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

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

[3]

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

Mark awarded for (a) =

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

...ron ... 2

... chemical properties.

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

...number of protons ... 3

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

Complete the table.

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

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

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

How the candidate could have improved the answer

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

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

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

Common mistakes candidates made in this question

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

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

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

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

Assessment at a glance

All candidates must enter for three papers.

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

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

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

Paper 4 – Theory (Extended)

Question 1

Example Candidate Response – Question 1, High	Examiner comments

1 Protons, neutrons and electrons are subatomic particles.

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

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

[3]

(b) Bromine has two isotopes.

(i) Define the term *isotope*.

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

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

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

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

Complete the table.

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

[5]

[Total: 12]

Mark awarded for (a) = 3 out of 3

Mark awarded for (b) = 4 out of 4

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

Mark awarded for (c) = 4 out of 5

Total mark awarded = 11 out of 12

How the candidate could have improved the answer

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

Example Candidate Response – Question 1, Middle

1 Protons, neutrons and electrons are subatomic particles.

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

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

[3]

(b) Bromine has two isotopes.

(i) Define the term *isotope*.

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

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

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

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

Complete the table.

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

[5]

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

N = nucleon − P

[Total: 12]

Examiner comments

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

Mark awarded for (a) = 1 out of 3

2 Correct.

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

Mark awarded for (b) = 2 out 4

4 The mass number (41) is missing.

Mark awarded for (c) = 4 out 5

Total marks awarded = 7 out of 12

How the candidate could have improved the answer

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

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

Example Candidate Response – Question 1, Low

Examiner comments

1 Protons, neutrons and electrons are subatomic particles.

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

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

[3]

(b) Bromine has two isotopes.

(i) Define the term *isotope*.

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

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

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

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

Complete the table.

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

[5]

[Total: 12]

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

Mark awarded for (a) = 0 out of 3

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

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

Mark awarded for (b) = 2 out 4

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

Mark awarded for (c) = 2 out 5

Total mark awarded = 4 out of 12

How the candidate could have improved the answer

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

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

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

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

Common mistakes candidates made in this question

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

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

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

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

Question 2

Example Candidate Response – Question 2, High	Examiner comments

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

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

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

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

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

0.04 ..... mol

- number of moles of O_2 formed,

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

0.02 ..... mol

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

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

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

1

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

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

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

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

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

1 Correct.

Mark awarded for (a) = 3 out of 3

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

3 Correct.

Mark awarded for (b) = 2 out 3

Example Candidate Response – Question 2, High	Examiner comments

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

Describe experiments to show that aluminium oxide is amphoteric.

4

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

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

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

Covalent [1]

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

High melting and boiling point

Insoluble in water. 5 [2]

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

(i) What is ionic bonding?

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

(ii) Deduce the formula of calcium phosphate.

$Ca_3(PO_4)_2$ 7 [1]

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

Mark awarded for (c) = 2 out of 3

5 Correct.

Mark awarded for (d) = 3 out of 3

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

7 Correct.

Mark awarded for (e) = 2 out 3

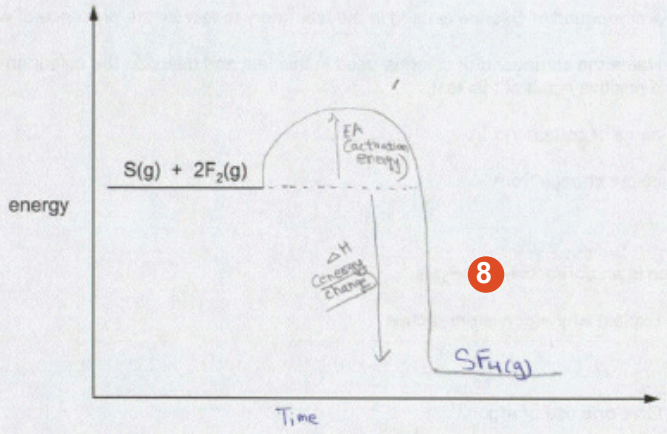
Example Candidate Response – Question 2, High	Examiner comments

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

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

The reaction is exothermic.

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

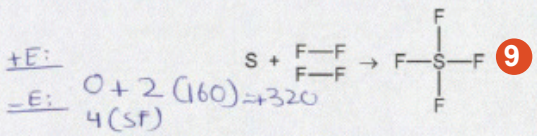


[3]

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

The F–F bond energy is 160 kJ/mol.

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



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

-E: 4 (SF)

320 − 4(x) = −780

x = 275

275 kJ/mol [3]

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

9 Correct.

Mark awarded for (f) = 5 out of 6

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

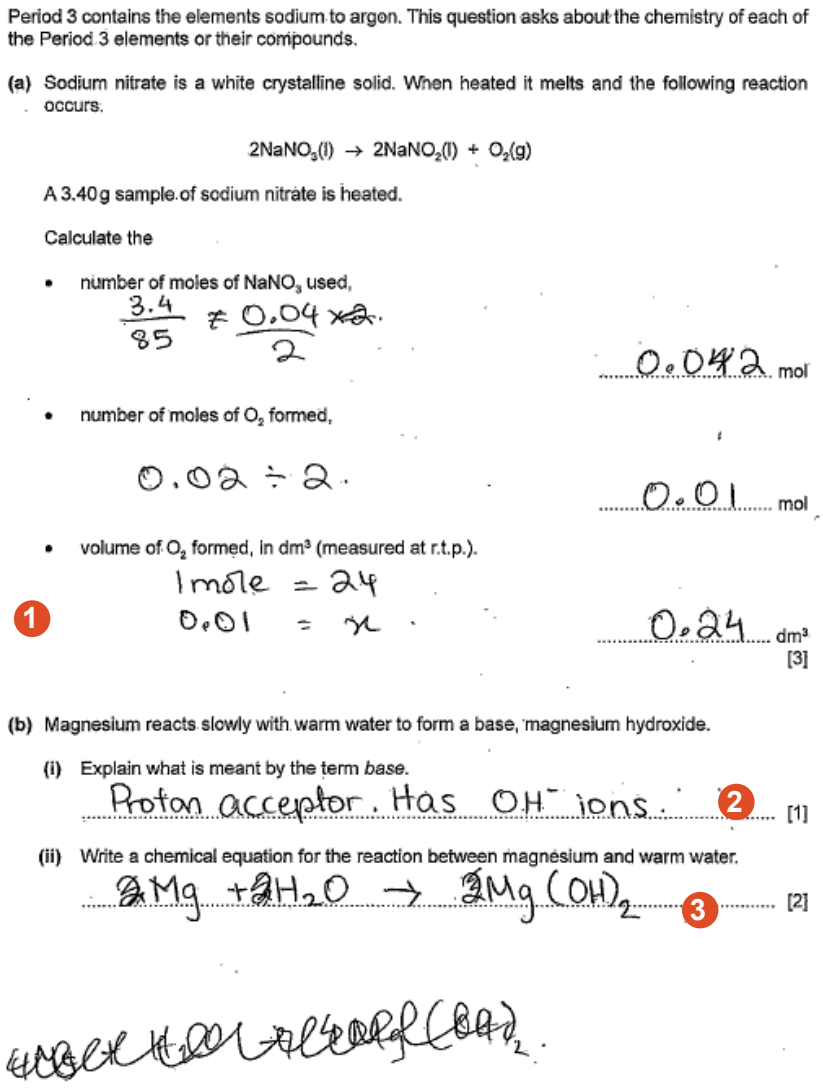
How the candidate could have improved the answer

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

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

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

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

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

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

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

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

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

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

0.042 mol

- number of moles of O_2 formed,

0.02 ÷ 2

0.01 mol

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

1 mole = 24

0.01 = x

0.24 dm^3 [3]

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

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

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

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

~~2~~Mg + ~~2~~H_2O → $Mg(OH)_2$ [2]

~~4~~Mg + H_2O → $Mg(OH)_2$.

Example Candidate Response – Question 2, Middle	Examiner comments

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

Describe experiments to show that aluminium oxide is amphoteric.

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

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

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

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

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

Covalent bonding 5 [1]

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

Very hard. and high density. 6 [2]

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

(i) What is ionic bonding?

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

(ii) Deduce the formula of calcium phosphate.

$Ca_3(PO_4)_2$ [1]

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

Mark awarded for (c) = 1 out of 3

5 Correct.

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

Mark awarded for (d) = 2 out of 3

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

Mark awarded for (e) = 2 out 3

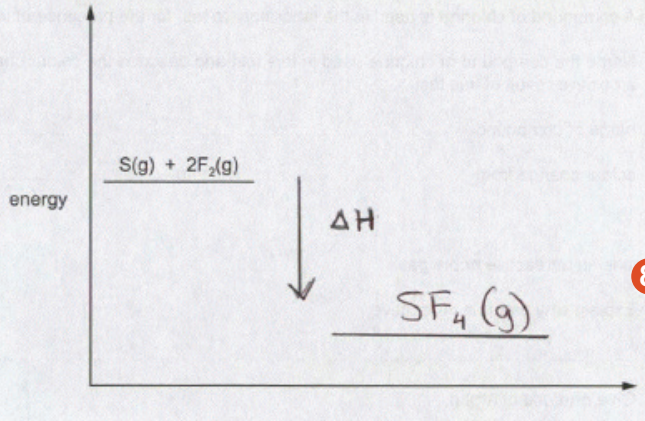
Example Candidate Response – Question 2, Middle	Examiner comments

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

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

The reaction is exothermic.

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



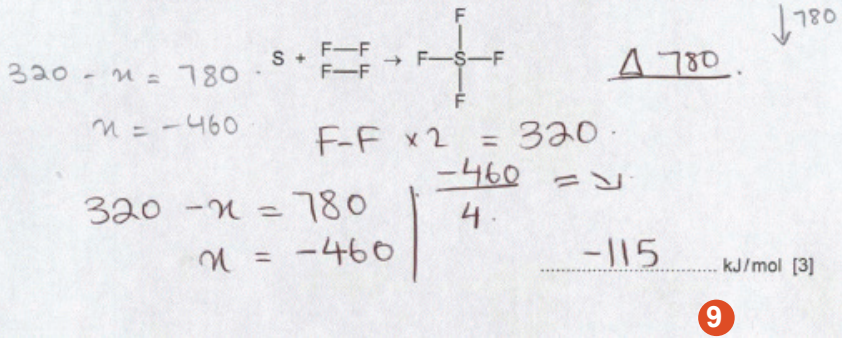
8

[3]

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

The F–F bond energy is 160 kJ/mol.

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



9

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

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

Mark awarded for (f) =
4 out of 6

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

How the candidate could have improved the answer

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

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

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

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

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

Example Candidate Response – Question 2, Low	Examiner comments

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

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

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

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

10 mol

- number of moles of O_2 formed,

6 mol

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

1

48 dm^3 [3]

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

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

it doesn't react 2 [1]

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

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

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

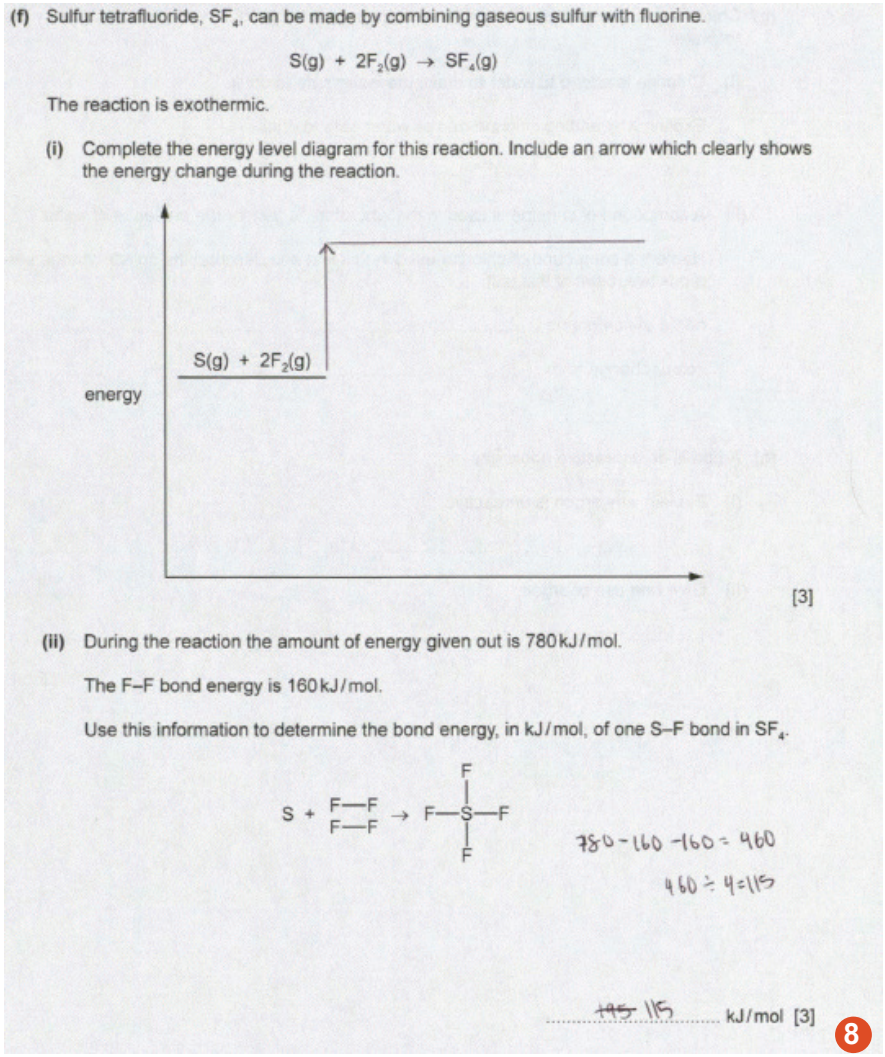
Mark awarded for (a) =
0 out of 3

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

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

Mark awarded for (b) =
0 out of 3

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

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

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

How the candidate could have improved the answer

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

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

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

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

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

Common mistakes candidates made in this question

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

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

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

(c) Failing to describe the experiment details.

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

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

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

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

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

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

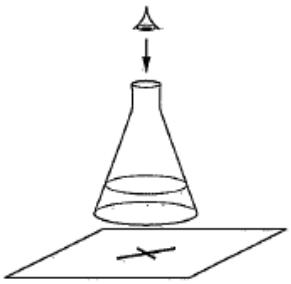
Question 3

Example Candidate Response – Question 3, High	Examiner comments

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

1 Correct

Mark awarded for (a) = 1 out of 1

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

3 Correct. Both points are adequately explained.

Mark awarded for (b) = 3 out of 4

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

Mark awarded for (c) = 2 out of 3

Total mark awarded = 6 out of 8

How the candidate could have improved the answer

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

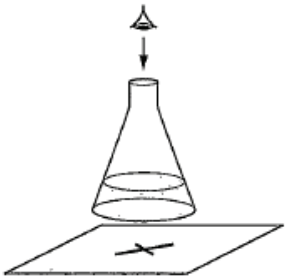
3 (c) The first two points earned marks, but the candidate needed to state that, as a result of the increased temperature, a higher proportion of collisions were able to reach activation energy.

Example Candidate Response – Question 3, Middle

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

Examiner comments

1 Correct.

Mark awarded for (a) = 1 out of 1

2 Correct.

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

Mark awarded for (b) = 2 out of 4

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

Mark awarded for (c) = 2 out of 3

Total mark awarded = 5 out of 8

How the candidate could have improved the answer

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

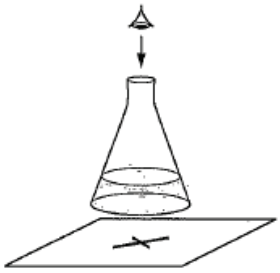
(c) The candidate gained the first two marks but needed to state that, as a result of increased temperature, a higher proportion of collisions were able to reach activation energy.

Example Candidate Response – Question 3, Low

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

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

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



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

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

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

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

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

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

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

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

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

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

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

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

Examiner comments

1 Correct.

Mark awarded for (a) =
1 out of 1

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

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

Mark awarded for (b) =
1 out of 4

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

Mark awarded for (c) =
1 out of 3

Total mark awarded =
3 out of 8

How the candidate could have improved the answer

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

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

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

Common mistakes candidates made in this question

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

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

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

Question 4

Example Candidate Response – Question 4, High	Examiner comments

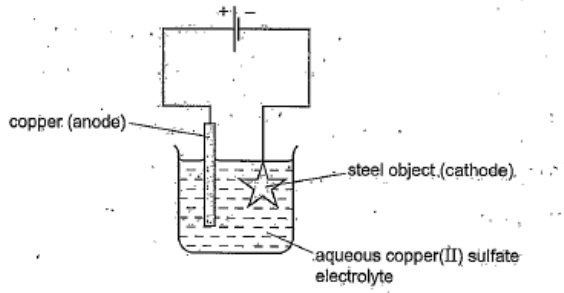
4. Electroplating steel objects with silver involves a three-step process.

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

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

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

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



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

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

Explain whether this process is oxidation or reduction.

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

1 Correct.

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

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

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

Mark awarded for (a) = 2 out of 3

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

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

3 Correct.

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

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

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

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

Mark awarded for (b) = 4 out of 5

Total mark awarded = 6 out of 8

How the candidate could have improved the answer

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

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

Example Candidate Response – Question 4, Middle	Examiner comments

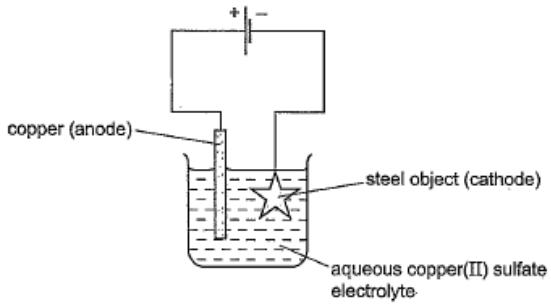
4 Electroplating steel objects with silver involves a three-step process.

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

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

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

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



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

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

Explain whether this process is oxidation or reduction.

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

1

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

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

2

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

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

3

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

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

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

4

1 Correct.

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

Mark awarded for (a) = 1 out of 3

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

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

Mark awarded for (b) = 2 out of 5

Total mark awarded = 3 out of 8

How the candidate could have improved the answer

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

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

Example Candidate Response – Question 4, Low	Examiner comments

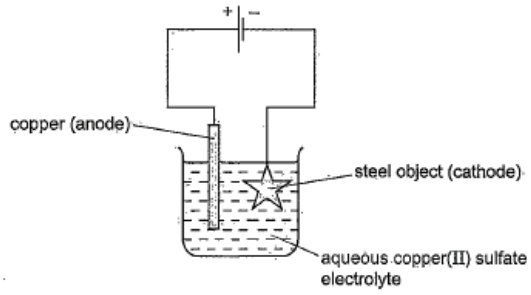
4 Electroplating steel objects with silver involves a three-step process.

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

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

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

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



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

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

Explain whether this process is oxidation or reduction.

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

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

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

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

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

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

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

- Malluable
- Ductile
- Shiney 4 [3]

1 Incorrect.

2 Incorrect.

Mark awarded for (a) = 0 out of 3

3 The candidate fails to name a suitable electrolyte.

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

Mark awarded for (b) = 1 out of 5

Total mark awarded = 1 out of 8

How the candidate could have improved the answer

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

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

Common mistakes candidates made in this question

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

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

Question 5

Example Candidate Response – Question 5, High	Examiner comments

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

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

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

Name a source of sulfur.

USA volcanoes in the USA (1) [1]

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

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

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

Complete the chemical equation for this reaction.

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

(d) Dilute sulfuric acid is a typical acid.

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

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

→ bubbles of gas

→ effervescence

→ solution changes blue (4) [2]

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

→ copper sulphate, carbon dioxide, water

(5) [1]

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

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

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

(ii) What type of reaction has occurred?

exothermic reaction (7) [1]

1 Correct.

Mark awarded for (a) = 1 out of 1

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

Mark awarded for (b) = 4 out of 5

3 Correct.

Mark awarded for (c) = 1 out of 1

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

5 Correct.

Mark awarded for (d) = 2 out of 3

6 The candidate fails to name the substance as carbon.

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

Mark awarded for (e) = 1 out of 2

Total mark awarded = 9 out of 12

How the candidate could have improved the answer

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

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

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

Example Candidate Response – Question 5, Middle

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

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

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

Name a source of sulfur.

Near volcanoes ..... [1]

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

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

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

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

Complete the chemical equation for this reaction.

$H_2SO_4 + SO_3 \rightarrow H_2S_2O_7$ [1]

(d) Dilute sulfuric acid is a typical acid.

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

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

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

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

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

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

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

(i) Name the black solid.

Carbon sulfite ..... [1]

(ii) What type of reaction has occurred?

Exothermic reaction ..... [1]

[Total: 12]

Examiner comments

1 Correct.

Mark awarded for (a) = 1 out of 1

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

Mark awarded for (b) = 1 out of 5

3 Correct.

Mark awarded for (c) = 1 out of 1

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

5 Correct.

Mark awarded for (d) = 1 out of 3

6 The candidate fails to name the substance as carbon.

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

Mark awarded for (e) = 1 out of 2

Total mark awarded = 5 out of 12

How the candidate could have improved the answer

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

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

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

Example Candidate Response – Question 5, Low

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

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

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

Name a source of sulfur.

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

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

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

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

2 [5]

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

Complete the chemical equation for this reaction.

$H_2SO_4 + SO_3 \rightarrow$ $H_2S_2O_7$ 3

[1]

H_2SC_7

$H_2S_2O_7$

(d) Dilute sulfuric acid is a typical acid.

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

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

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

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

- Copper Sulphate
- Carbon sulfate. 5 [1]

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

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

(i) Name the black solid.

Carbon. 6 [1]

(ii) What type of reaction has occurred?

A displacement reaction. 7 [1]

[Total: 12]

Examiner comments

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

Mark awarded for (a) = 0 out of 1

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

Mark awarded for (b) = 1 out of 5

3 Correct.

Mark awarded for (c) = 1 out of 1

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

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

Mark awarded for (d) = 0 out of 3

6 Correct.

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

Mark awarded for (e) = 1 out of 2

Total mark awarded = 3 out of 12

How the candidate could have improved the answer

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

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

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

Common mistakes candidates made in this question

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

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

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

Question 6

Example Candidate Response – Question 6, High	Examiner comments

6 Petroleum is a source of many important chemicals.

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

Fractional Distillation, Cracking

1

[2]

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

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

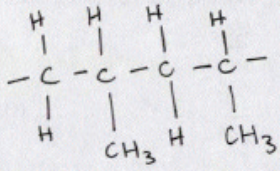
Addition Polymerisation [1]

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

[1]

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

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



2

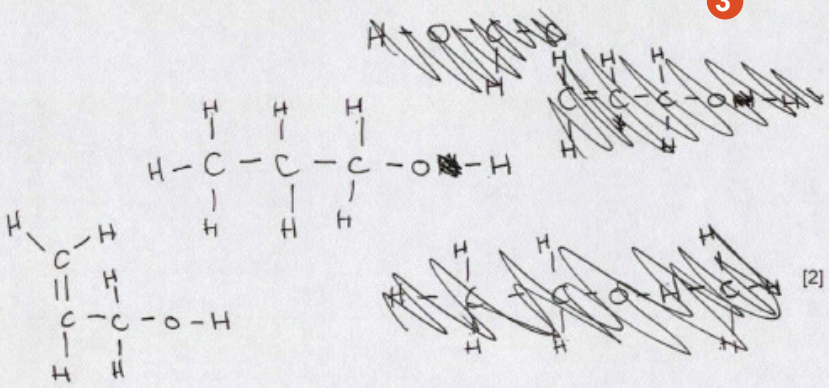
[2]

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

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

Suggest the structures of these alcohols.

3



[2]

1 Correct.

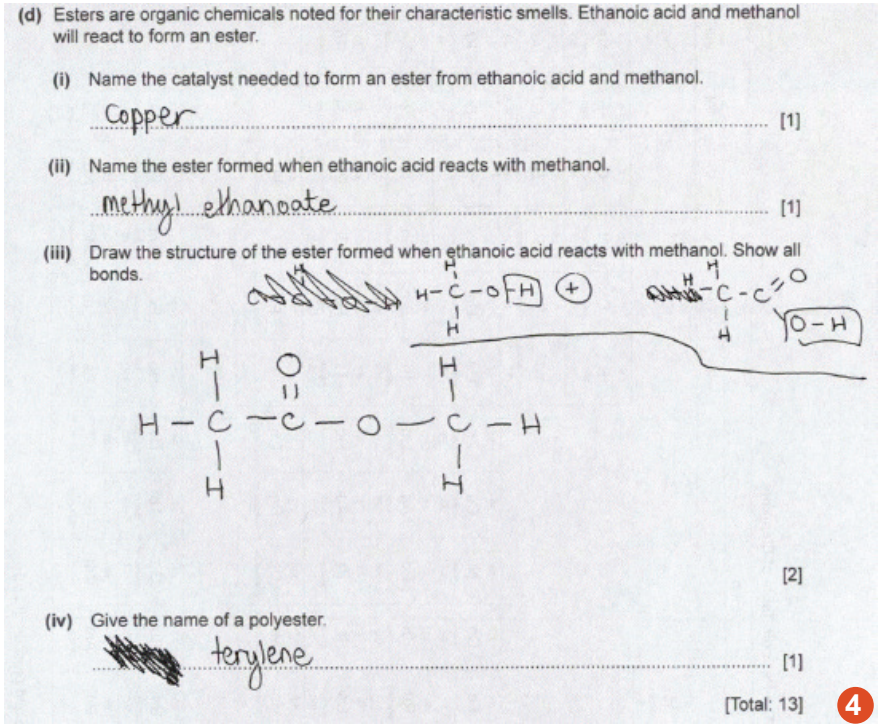
Mark awarded for (a) = 2 out of 2

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

Mark awarded for (b) = 3 out of 4

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

Mark awarded for (c) = 1 out of 2

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

How the candidate could have improved the answer

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

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

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

Example Candidate Response – Question 6, Low	Examiner comments

6 Petroleum is a source of many important chemicals.

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

→ Burning of ~~fossil~~ fossil fuel.

→ Extracting petroleum 1 [2]

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

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

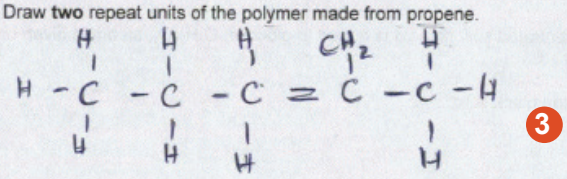
Addition polymerisation. [1]

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

~~C_2H_4~~ C_6H_8 2 [1]

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

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



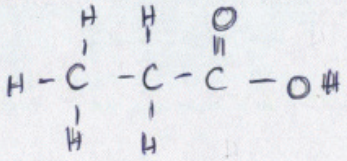
3

[2]

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

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

Suggest the structures of these alcohols.



4

1 The candidate fails to correctly name two industrial processes.

Mark awarded for (a) = 0 out of 2

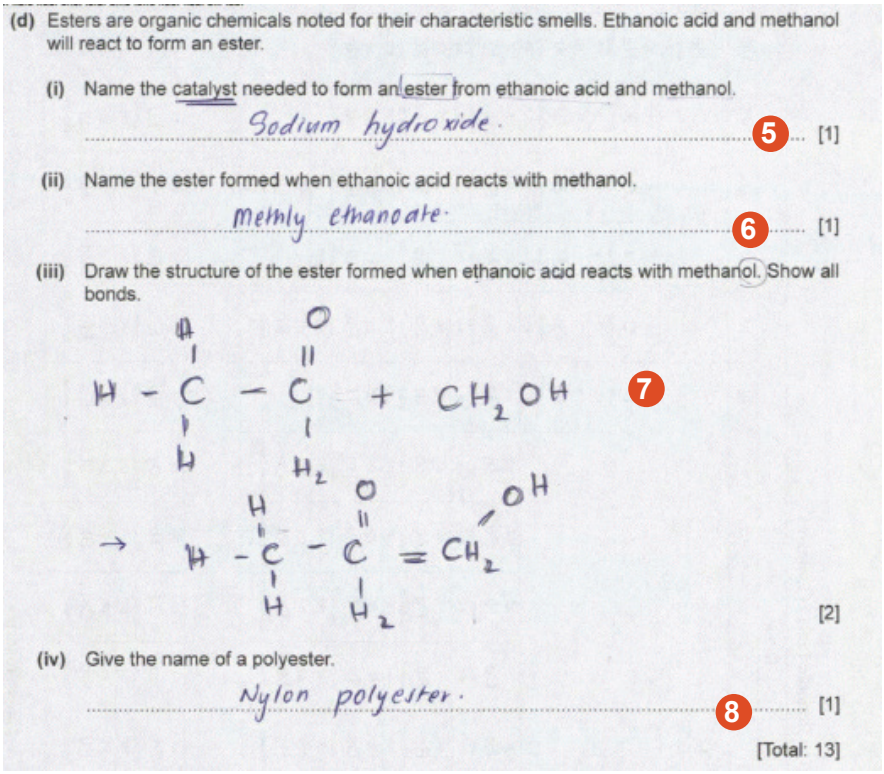
2 The candidate fails to show the empirical formula of the polymer.

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

Mark awarded for (b) = 1 out of 4

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

Mark awarded for (c) = 0 out of 2

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

How the candidate could have improved the answer

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

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

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

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

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

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

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

Common mistakes candidates made in this question

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

(b) (iii) Assuming that two repeat units of (poly)propene is 6 CH_2 groups in a row.

(d) (iv) Thinking that nylon is a polyester.

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